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1 Machine Learning Assignment 2

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```
[267]: import matplotlib.pyplot as plt
import numpy as np
import numpy.random
import numpy.linalg
import scipy.io
import scipy.stats
import sklearn.metrics

# setup plotting
from IPython import get_ipython
import psutil
inTerminal = not "IPKernelApp" in get_ipython().config
inJupyterNb = any(filter(lambda x: x.endswith("jupyter-notebook"), psutil.
    ↪Process().parent().cmdline()))
get_ipython().run_line_magic("matplotlib", "" if inTerminal else "notebook" if
    ↪inJupyterNb else "widget")
def nextplot():
    if inTerminal:
        plt.clf()      # this clears the current plot
    else:
        plt.figure()  # this creates a new plot
```

```
[268]: %matplotlib widget
```

2 Load the data

```
[269]: data = scipy.io.loadmat("data/spamData.mat")
X = data["Xtrain"]
N = X.shape[0]
D = X.shape[1]
Xtest = data["Xtest"]
Ntest = Xtest.shape[0]
```

```

y = data["ytrain"].squeeze().astype(int)
ytest = data["ytest"].squeeze().astype(int)

features = np.array(
    [
        "word_freq_make",
        "word_freq_address",
        "word_freq_all",
        "word_freq_3d",
        "word_freq_our",
        "word_freq_over",
        "word_freq_remove",
        "word_freq_internet",
        "word_freq_order",
        "word_freq_mail",
        "word_freq_receive",
        "word_freq_will",
        "word_freq_people",
        "word_freq_report",
        "word_freq_addresses",
        "word_freq_free",
        "word_freq_business",
        "word_freq_email",
        "word_freq_you",
        "word_freq_credit",
        "word_freq_your",
        "word_freq_font",
        "word_freq_000",
        "word_freq_money",
        "word_freq_hp",
        "word_freq_hpl",
        "word_freq_george",
        "word_freq_650",
        "word_freq_lab",
        "word_freq_labs",
        "word_freq_telnet",
        "word_freq_857",
        "word_freq_data",
        "word_freq_415",
        "word_freq_85",
        "word_freq_technology",
        "word_freq_1999",
        "word_freq_parts",
        "word_freq_pm",
        "word_freq_direct",
        "word_freq_cs",
        "word_freq_meeting",
    ]
)

```

```

        "word_freq_original",
        "word_freq_project",
        "word_freq_re",
        "word_freq_edu",
        "word_freq_table",
        "word_freq_conference",
        "char_freq;",
        "char_freq(",
        "char_freq[",
        "char_freq!",
        "char_freq$",
        "char_freq#",
        "capital_run_length_average",
        "capital_run_length_longest",
        "capital_run_length_total",
    ]
)

```

3 1. Dataset Statistics

```

[270]: # look some dataset statistics
scipy.stats.describe(X)

```

```

[270]: DescribeResult(nobs=3065, minmax=(array([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., 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., 1., 1., 1.]), array([4.5400e+00, 1.4280e+01, 5.1000e+00,
4.2810e+01, 9.0900e+00,
        3.5700e+00, 7.2700e+00, 1.1110e+01, 3.3300e+00, 1.8180e+01,
        2.0000e+00, 9.6700e+00, 5.5500e+00, 5.5500e+00, 2.8600e+00,
        1.0160e+01, 7.1400e+00, 9.0900e+00, 1.8750e+01, 6.3200e+00,
        1.1110e+01, 1.7100e+01, 5.4500e+00, 9.0900e+00, 2.0000e+01,
        1.4280e+01, 3.3330e+01, 4.7600e+00, 1.4280e+01, 4.7600e+00,
        4.7600e+00, 4.7600e+00, 1.8180e+01, 4.7600e+00, 2.0000e+01,
        7.6900e+00, 6.8900e+00, 7.4000e+00, 9.7500e+00, 4.7600e+00,
        7.1400e+00, 1.4280e+01, 3.5700e+00, 2.0000e+01, 2.1420e+01,
        1.6700e+01, 2.1200e+00, 1.0000e+01, 4.3850e+00, 9.7520e+00,
        4.0810e+00, 3.2478e+01, 6.0030e+00, 1.9829e+01, 1.1025e+03,
        9.9890e+03, 1.5841e+04])), mean=array([1.10818923e-01, 2.28486134e-01,
2.74153344e-01, 6.29690049e-02,
        3.17787928e-01, 9.57553018e-02, 1.13546493e-01, 1.07216966e-01,
        8.89233279e-02, 2.41719413e-01, 5.81305057e-02, 5.37432300e-01,
        9.26231648e-02, 4.96639478e-02, 5.07210440e-02, 2.35334421e-01,
        1.47197390e-01, 1.86600326e-01, 1.66121044e+00, 7.63066884e-02,
        8.19592170e-01, 1.22727569e-01, 1.02006525e-01, 8.90799347e-02,

```

```

5.29800979e-01, 2.62071778e-01, 7.71507341e-01, 1.14323002e-01,
1.09487765e-01, 9.92952692e-02, 6.28156607e-02, 4.90342577e-02,
9.27471452e-02, 4.96019576e-02, 1.02156607e-01, 9.93050571e-02,
1.43285481e-01, 1.24274062e-02, 7.55921697e-02, 6.60456770e-02,
4.63360522e-02, 1.32176183e-01, 4.88580750e-02, 7.11876020e-02,
3.06590538e-01, 1.79794454e-01, 5.28874388e-03, 3.13768352e-02,
3.79543230e-02, 1.38396411e-01, 1.81830343e-02, 2.65470799e-01,
7.91275693e-02, 5.34218597e-02, 4.90062936e+00, 5.26750408e+01,
2.82203915e+02]), variance=array([1.07094140e-01, 1.88742036e+00,
2.34317437e-01, 1.78161723e+00,
4.40325719e-01, 6.79193461e-02, 1.39844435e-01, 1.72001423e-01,
6.97247542e-02, 4.69800274e-01, 3.58302179e-02, 7.59167719e-01,
9.28365241e-02, 8.26118648e-02, 7.00470321e-02, 4.29393369e-01,
2.00636301e-01, 2.92991898e-01, 3.18992370e+00, 1.65626303e-01,
1.44315254e+00, 1.01505046e+00, 1.19749530e-01, 1.43862796e-01,
2.45800502e+00, 7.38036013e-01, 1.13920029e+01, 2.31010973e-01,
4.31507668e-01, 1.90528093e-01, 1.24671084e-01, 1.07425177e-01,
2.95159161e-01, 1.07745599e-01, 3.08154062e-01, 1.67896547e-01,
1.85791650e-01, 4.34829439e-02, 1.42525114e-01, 1.16865102e-01,
1.50361473e-01, 6.09903912e-01, 5.73945833e-02, 3.19259425e-01,
1.01935877e+00, 8.17471270e-01, 4.63438951e-03, 7.50333517e-02,
5.54612799e-02, 7.77968333e-02, 1.48045497e-02, 7.59181612e-01,
6.74541224e-02, 2.69600271e-01, 7.42311765e+02, 4.86573219e+04,
3.68952901e+05]), skewness=array([ 5.92257918,  9.5555492 ,  2.94110789,
27.15035267,  4.22000271,
4.55490419,  6.21454549, 10.63604439,  4.44795353,  9.63368819,
5.1601559 ,  3.12797362,  7.99555783, 10.07103212,  6.44051978,
5.9017492 ,  5.71193665,  5.63845456,  1.6918398 ,  8.05102821,
2.36131511,  9.70708774,  5.74851972, 13.62929854,  5.51200726,
5.77490458,  5.72163481,  5.84582426, 11.30526457,  6.67894971,
8.78006633, 10.35563132, 16.1291286 , 10.31146394, 17.98980105,
7.86085564,  5.29526945, 27.69555992, 10.51869112,  9.12514394,
12.60532735,  9.42688905,  7.88762618, 19.69945392,  9.63372543,
8.97501221, 18.94255005, 20.98217881, 14.12336521, 16.36382061,
21.32440567, 21.32959254, 10.88427173, 26.25786993, 27.34951229,
31.14016596,  9.80477376]), kurtosis=array([ 51.71558405,  93.89016173,
13.18839908,  785.40163828,
28.69487647,  31.20576951,  66.53150801, 198.68010939,
28.29530115, 185.40607771,  34.48800593,  15.18712484,
109.66544541, 138.05561341,  44.19188958,  55.62892 ,
47.49151277,  52.75647121,  6.32523058,  77.87379384,
8.48736408, 103.7022867 ,  49.37553046, 272.09125904,
42.43992409,  49.41302953,  33.63974328,  39.86629858,
166.19735746,  53.12216402,  91.72439904, 124.79234055,
433.42661801, 123.97955409, 555.16708959,  86.72460731,
43.92486688, 865.39968623, 181.33012173, 100.87592785,
189.11563172, 111.21705016,  81.96093958, 567.75150773,

```

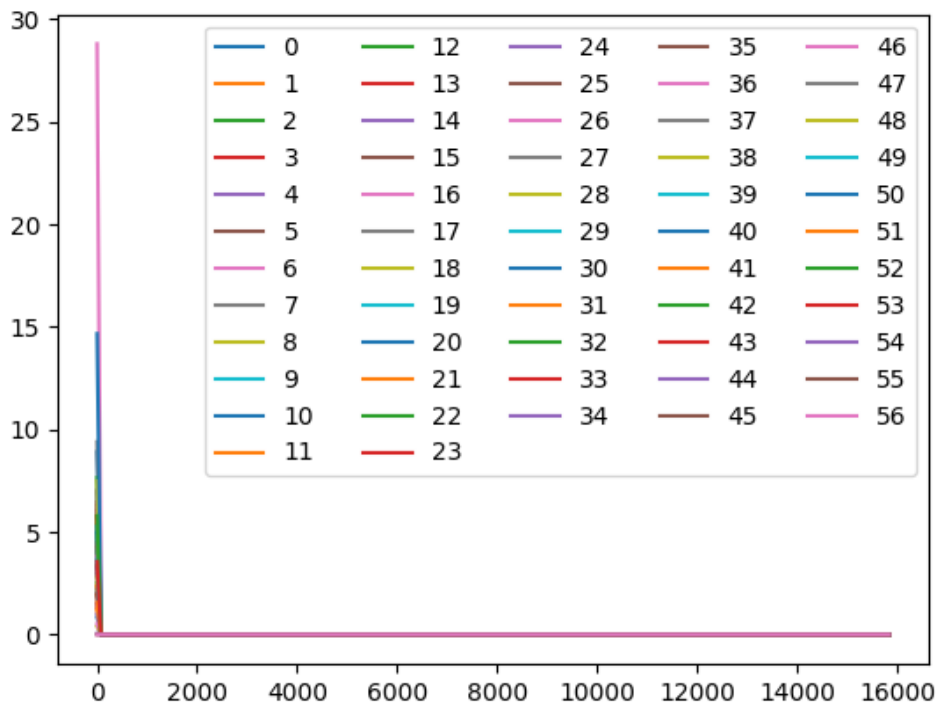
```
147.5283386 , 107.79164424, 445.8361165 , 634.57001982,
228.75884956, 499.07842266, 588.19774644, 688.05527222,
184.31757803, 851.48819158, 954.59095344, 1348.49464105,
183.78053905]))
```

```
[271]: scipy.stats.describe(y)
```

```
[271]: DescribeResult(nobs=3065, minmax=(np.int64(0), np.int64(1)),
mean=np.float64(0.39738988580750406), variance=np.float64(0.23954932085067235),
skewness=np.float64(0.41936632478193103),
kurtosis=np.float64(-1.824131885638896))
```

```
[272]: # plot the distribution of all features
nextplot()
densities = [scipy.stats.gaussian_kde(X[:, j]) for j in range(D)]
xs = np.linspace(0, np.max(X), 200)
for j in range(D):
    plt.plot(xs, densities[j](xs), label=j)
plt.legend(ncol=5)
```

```
[272]: <matplotlib.legend.Legend at 0x7be9dbb03ac0>
```



```
[273]: # this plots is not really helpful; go now explore further
# YOUR CODE HERE
```

4 First Observation

- there is a very high spike around [0, 1]

```
[274]: import pandas as pd

df = pd.DataFrame(X)
df.head()
```

```
[274]:
```

	0	1	2	3	4	5	6	7	8	9	...	47	48	\
0	0.21	0.28	0.5	0.0	0.14	0.28	0.21	0.07	0.00	0.94	...	0.0	0.0	
1	0.00	0.00	0.0	0.0	0.63	0.00	0.31	0.63	0.31	0.63	...	0.0	0.0	
2	0.00	0.00	0.0	0.0	0.63	0.00	0.31	0.63	0.31	0.63	...	0.0	0.0	
3	0.00	0.00	0.0	0.0	1.85	0.00	0.00	1.85	0.00	0.00	...	0.0	0.0	
4	0.00	0.00	0.0	0.0	1.92	0.00	0.00	0.00	0.00	0.64	...	0.0	0.0	

	49	50	51	52	53	54	55	56
0	0.132	0.0	0.372	0.180	0.048	5.114	101.0	1028.0
1	0.137	0.0	0.137	0.000	0.000	3.537	40.0	191.0
2	0.135	0.0	0.135	0.000	0.000	3.537	40.0	191.0
3	0.223	0.0	0.000	0.000	0.000	3.000	15.0	54.0
4	0.054	0.0	0.164	0.054	0.000	1.671	4.0	112.0

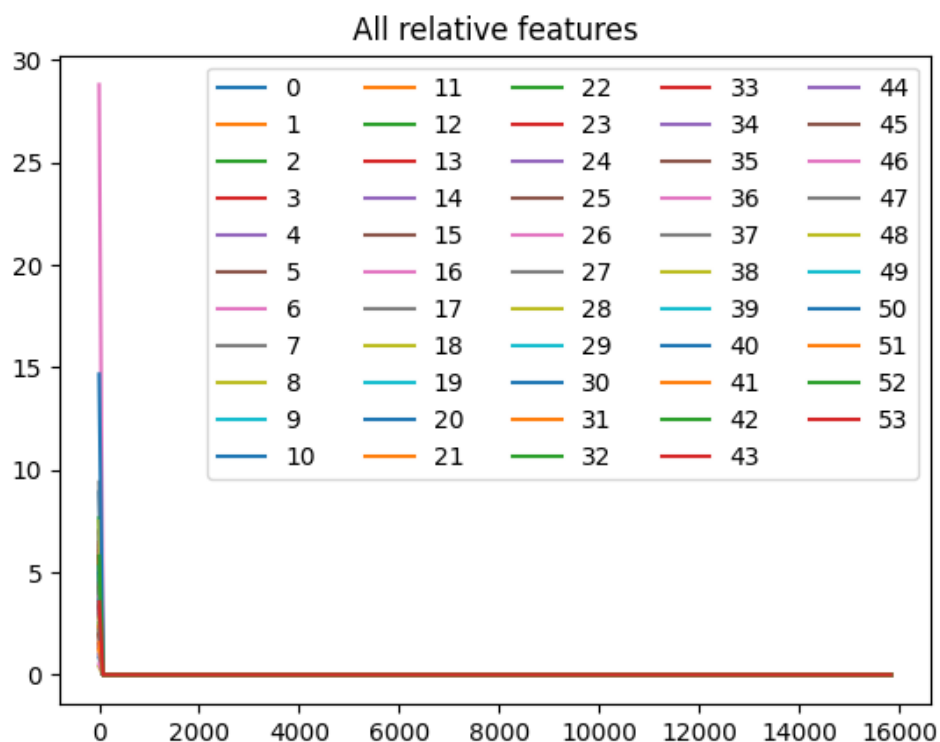
[5 rows x 57 columns]

5 Second Observation

- the last 3 features are absolute features representing direct measurements -> this can be derived from the fact that they are not in the range of 0 and 1
- the first 54 features are relative features since they represent ratios from 0 to 1.

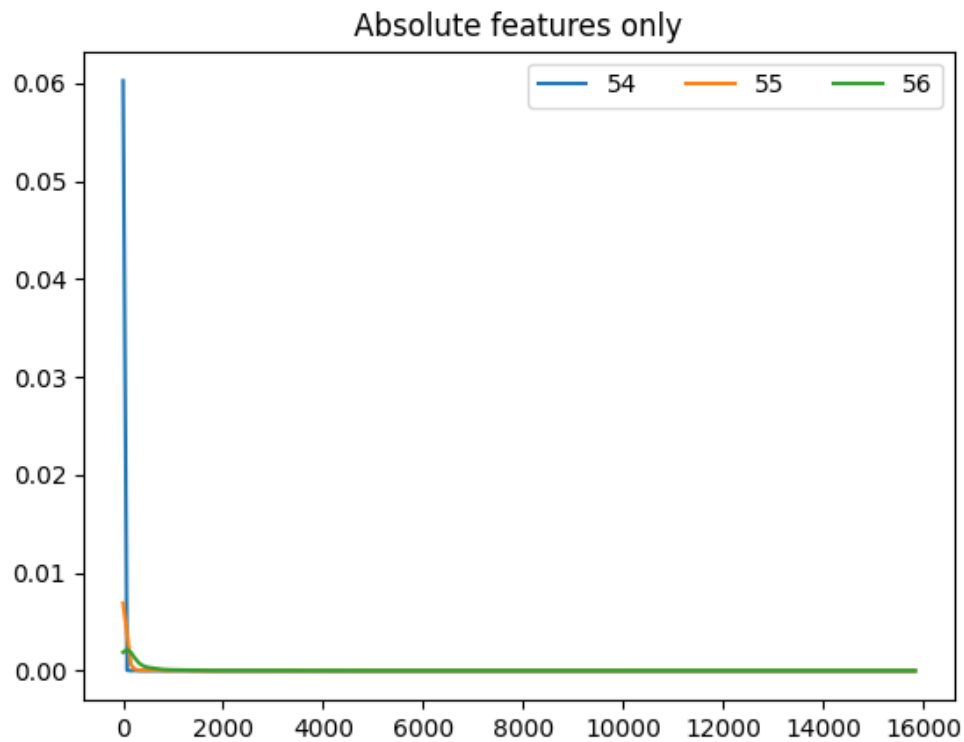
```
[275]: nextplot()
densities = [scipy.stats.gaussian_kde(X[:, j]) for j in range(D-3)]
xs = np.linspace(0, np.max(X), 200)
for j in range(D-3):
    plt.plot(xs, densities[j](xs), label=j)
plt.legend(ncol=5)
plt.title('All relative features')
```

```
[275]: Text(0.5, 1.0, 'All relative features')
```



```
[276]: nextplot()
densities = [scipy.stats.gaussian_kde(X[:, j]) for j in range(D)]
xs = np.linspace(0, np.max(X), 200)
for j in range(D-3, D):
    plt.plot(xs, densities[j](xs), label=j)
plt.legend(ncol=5)
plt.title('Absolute features only')
```

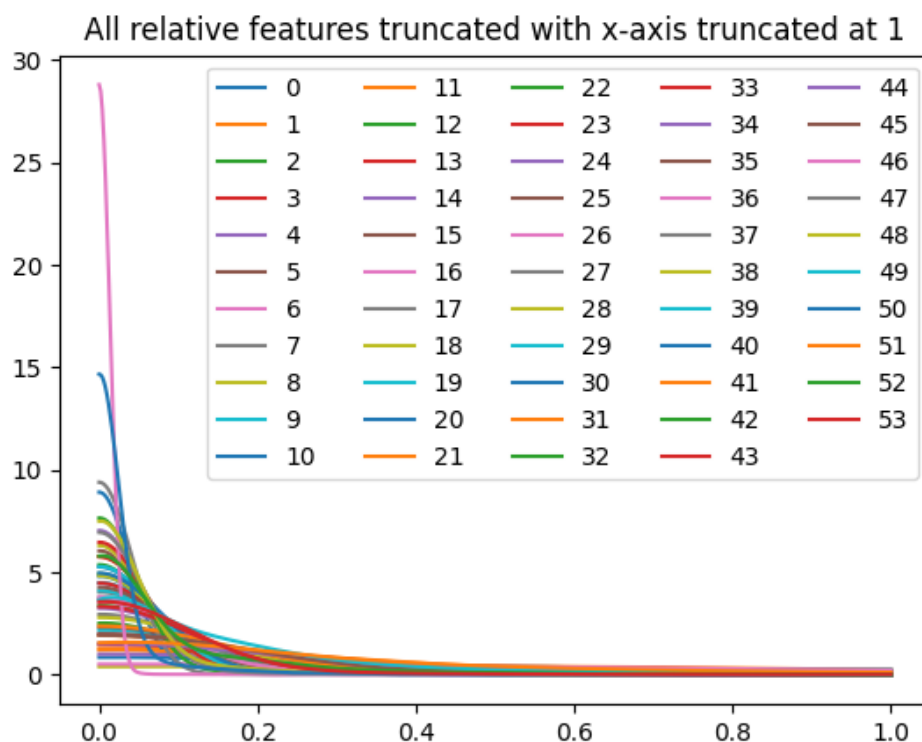
```
[276]: Text(0.5, 1.0, 'Absolute features only')
```



```
[277]: nextplot()
densities = [scipy.stats.gaussian_kde(X[:, j]) for j in range(D-3)]
xs = np.linspace(0, 1, 500) # changing the x axis scale: most of the density is
    ↪ between 0 and 0.4

for j in range(D-3):
    plt.plot(xs, densities[j](xs), label=j) # or features[j]
plt.legend(ncol=5)
plt.title('All relative features truncated with x-axis truncated at 1')
```

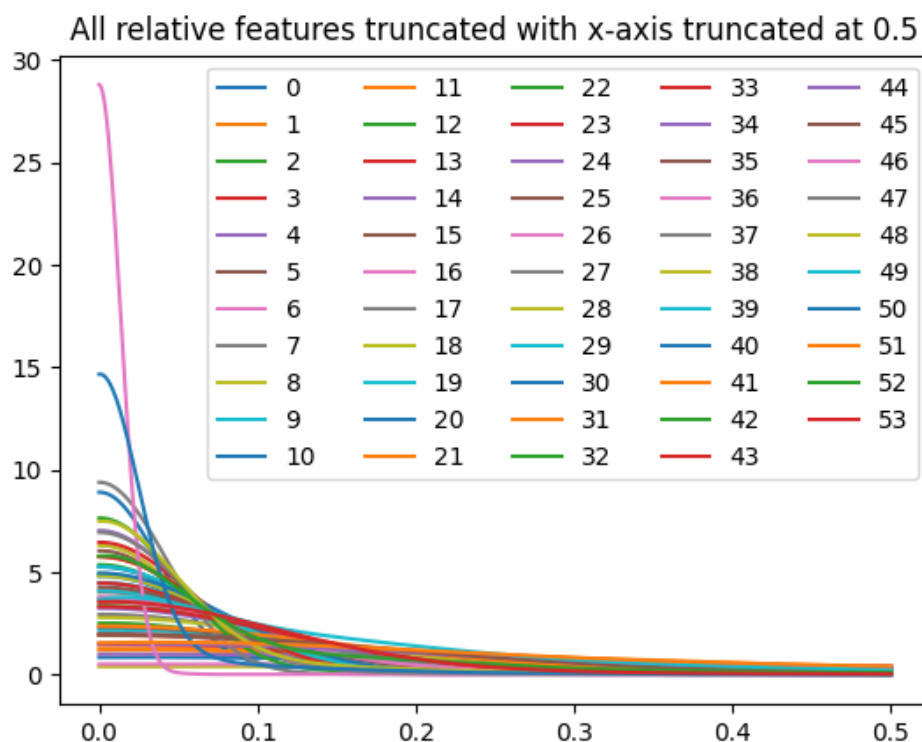
```
[277]: Text(0.5, 1.0, 'All relative features truncated with x-axis truncated at 1')
```

```
[278]: nextplot()
densities = [scipy.stats.gaussian_kde(X[:, j]) for j in range(D-3)]
xs = np.linspace(0, 0.5, 500) # changing the x axis scale: most of the density
    ↪ is between 0 and 0.4

for j in range(D-3):
    plt.plot(xs, densities[j](xs), label=j) # or features[j]
plt.legend(ncol=5)
plt.title('All relative features truncated with x-axis truncated at 0.5')
```

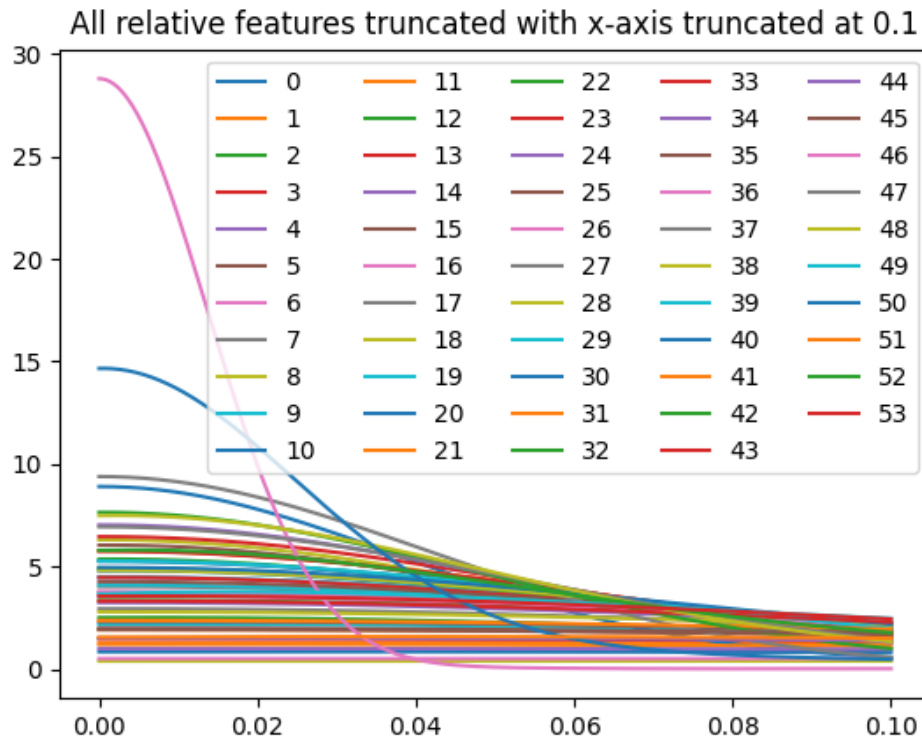
```
[278]: Text(0.5, 1.0, 'All relative features truncated with x-axis truncated at 0.5')
```



```
[279]: nextplot()
densities = [scipy.stats.gaussian_kde(X[:, j]) for j in range(D-3)]
xs = np.linspace(0, 0.1, 500) # changing the x axis scale: most of the density
    ↪ is between 0 and 0.4

for j in range(D-3):
    plt.plot(xs, densities[j](xs), label=j) # or features[j]
plt.legend(ncol=5)
plt.title('All relative features truncated with x-axis truncated at 0.1')
```

```
[279]: Text(0.5, 1.0, 'All relative features truncated with x-axis truncated at 0.1')
```



```
[280]: # Let's compute z-scores; create two new variables Xz and Xtestz.
from sklearn.preprocessing import StandardScaler

# Initialize the scaler
scaler = StandardScaler()

# Fit the scaler on the training data and transform both training and test data
Xz = scaler.fit_transform(X)
Xtestz = scaler.transform(Xtest)

# Check the resulting standardized datasets
print("Mean of each feature in Xz (should be ~0):", np.mean(Xz, axis=0))
print("Standard deviation of each feature in Xz (should be ~1):", np.std(Xz,
    ↪axis=0))
print("Mean of each feature in Xtestz (should be ~0):", np.mean(Xtestz, axis=0))
print("Standard deviation of each feature in Xtestz (should be ~1):", np.
    ↪std(Xtestz, axis=0))
```

```
Mean of each feature in Xz (should be ~0): [ 1.85459768e-17  9.27298839e-18
-5.56379304e-17 -9.27298839e-18
 5.56379304e-17  3.70919536e-17  0.00000000e+00 -7.41839072e-17
```

```

5.56379304e-17 0.00000000e+00 -1.85459768e-17 -2.43415945e-17
-4.63649420e-17 1.85459768e-17 1.85459768e-17 3.70919536e-17
-3.70919536e-17 -9.27298839e-17 -1.66913791e-16 9.27298839e-18
1.85459768e-17 9.27298839e-18 -5.56379304e-17 -1.85459768e-17
-6.49109188e-17 -3.70919536e-17 -1.85459768e-17 1.85459768e-17
-2.78189652e-17 4.63649420e-17 -1.85459768e-17 5.56379304e-17
0.00000000e+00 -1.85459768e-17 3.70919536e-17 1.85459768e-17
-9.27298839e-18 4.63649420e-18 1.85459768e-17 9.27298839e-18
2.31824710e-17 -2.78189652e-17 -9.27298839e-18 4.63649420e-18
-9.27298839e-18 -9.27298839e-18 1.39094826e-17 -2.78189652e-17
-3.70919536e-17 -6.49109188e-17 4.63649420e-18 3.70919536e-17
-3.70919536e-17 9.27298839e-18 -9.27298839e-18 9.27298839e-18
-7.41839072e-17]
Standard deviation of each feature in Xz (should be ~1): [1. 1. 1. 1. 1. 1. 1.
1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
1. 1. 1. 1. 1. 1. 1. 1. 1.]
Mean of each feature in Xtestz (should be ~0): [-5.73600192e-02 -3.37389835e-02
4.02481250e-02 5.51233798e-03
-2.51229644e-02 1.67364997e-03 5.29785531e-03 -1.38875040e-02
1.29802458e-02 -1.00804532e-02 2.68026912e-02 1.46804853e-02
1.28455840e-02 9.34193448e-02 -1.71666713e-02 6.17841473e-02
-3.08405298e-02 -1.02710095e-02 1.49139906e-03 6.82438979e-02
-2.45179646e-02 -4.53675036e-03 -3.12737328e-03 4.09841941e-02
3.76515934e-02 1.15494599e-02 -3.73018154e-03 6.55839018e-02
-4.82178216e-02 2.44089391e-02 1.64408852e-02 -1.81514851e-02
2.47142980e-02 -1.61248615e-02 1.75684573e-02 -1.33686432e-02
-4.40153254e-02 1.11212504e-02 2.40959269e-02 -1.06211719e-02
-2.06246544e-02 6.23149655e-04 -3.45073187e-02 4.24615929e-02
-1.59254291e-02 9.77429328e-05 6.85319587e-03 5.38462415e-03
7.89156240e-03 6.81007462e-03 -2.97234292e-02 1.23785037e-02
-3.82610483e-02 -5.29891640e-02 3.19860888e-02 -6.82149671e-03
5.35333143e-03]
Standard deviation of each feature in Xtestz (should be ~1): [0.7814603
0.8046511 1.11934658 1.13025046 1.03980406 1.14531115
1.13444999 0.89784017 1.15746733 0.80953007 1.18336095 0.96669832
0.96372882 1.43973845 0.93263701 1.66122883 0.97373622 0.94276053
0.98235473 1.64369068 0.99870796 1.05350786 1.03641016 1.4433867
1.18666147 1.09440781 0.99312029 1.32788084 0.66861325 1.13288279
1.38368011 1.00735735 1.06805083 1.01097984 0.87092113 0.9470354
0.94580152 1.16565989 1.40553929 1.06920116 0.77698549 0.9448789
0.78635376 1.27804343 1.00616124 1.02310589 1.32862863 1.12439059
1.09839086 0.9050551 0.65235216 0.79362614 0.82984222 0.22581694
1.43766401 0.58571989 0.99488232]

```

```

[281]: # Let's check. Xz and Xtestz refer to the normalized datasets just created. We
# will use them throughout.

```

```

np.mean(Xz, axis=0) # should be all 0
np.var(Xz, axis=0) # should be all 1
np.mean(Xtestz, axis=0) # what do you get here?
np.var(Xtestz, axis=0)

np.sum(Xz ** 3) # should be: 1925261.15

```

[281]: np.float64(1925261.1560010156)

```

[282]: # Explore the normalized data
# YOUR CODE HERE
# Let's check. Xz and Xtestz refer to the normalized datasets just created. We
# will use them throughout.
print(np.mean(Xz, axis=0)) # should be all 0
print(np.var(Xz, axis=0)) # should be all 1
print(np.mean(Xtestz, axis=0)) # what do you get here?
print(np.var(Xtestz, axis=0))

print(np.sum(Xz ** 3)) # should be: 1925261.15

```

```

[ 1.85459768e-17  9.27298839e-18 -5.56379304e-17 -9.27298839e-18
  5.56379304e-17  3.70919536e-17  0.00000000e+00 -7.41839072e-17
  5.56379304e-17  0.00000000e+00 -1.85459768e-17 -2.43415945e-17
 -4.63649420e-17  1.85459768e-17  1.85459768e-17  3.70919536e-17
 -3.70919536e-17 -9.27298839e-17 -1.66913791e-16  9.27298839e-18
  1.85459768e-17  9.27298839e-18 -5.56379304e-17 -1.85459768e-17
 -6.49109188e-17 -3.70919536e-17 -1.85459768e-17  1.85459768e-17
 -2.78189652e-17  4.63649420e-17 -1.85459768e-17  5.56379304e-17
  0.00000000e+00 -1.85459768e-17  3.70919536e-17  1.85459768e-17
 -9.27298839e-18  4.63649420e-18  1.85459768e-17  9.27298839e-18
  2.31824710e-17 -2.78189652e-17 -9.27298839e-18  4.63649420e-18
 -9.27298839e-18 -9.27298839e-18  1.39094826e-17 -2.78189652e-17
 -3.70919536e-17 -6.49109188e-17  4.63649420e-18  3.70919536e-17
 -3.70919536e-17  9.27298839e-18 -9.27298839e-18  9.27298839e-18
 -7.41839072e-17]
[1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
 1. 1. 1. 1. 1. 1. 1. 1. 1.]
[-5.73600192e-02 -3.37389835e-02  4.02481250e-02  5.51233798e-03
 -2.51229644e-02  1.67364997e-03  5.29785531e-03 -1.38875040e-02
  1.29802458e-02 -1.00804532e-02  2.68026912e-02  1.46804853e-02
  1.28455840e-02  9.34193448e-02 -1.71666713e-02  6.17841473e-02
 -3.08405298e-02 -1.02710095e-02  1.49139906e-03  6.82438979e-02
 -2.45179646e-02 -4.53675036e-03 -3.12737328e-03  4.09841941e-02
  3.76515934e-02  1.15494599e-02 -3.73018154e-03  6.55839018e-02
 -4.82178216e-02  2.44089391e-02  1.64408852e-02 -1.81514851e-02
  2.47142980e-02 -1.61248615e-02  1.75684573e-02 -1.33686432e-02]

```

```

-4.40153254e-02  1.11212504e-02  2.40959269e-02 -1.06211719e-02
-2.06246544e-02  6.23149655e-04 -3.45073187e-02  4.24615929e-02
-1.59254291e-02  9.77429328e-05  6.85319587e-03  5.38462415e-03
 7.89156240e-03  6.81007462e-03 -2.97234292e-02  1.23785037e-02
-3.82610483e-02 -5.29891640e-02  3.19860888e-02 -6.82149671e-03
 5.35333143e-03]
[0.61068019 0.64746339 1.25293677 1.2774661  1.08119249 1.31173762
 1.28697678 0.80611698 1.33973062 0.65533893 1.40034314 0.93450565
 0.92877323 2.0728468  0.86981179 2.75968123 0.94816223 0.88879741
 0.96502082 2.70171906 0.99741759 1.1098788  1.07414603 2.08336518
 1.40816544 1.19772845 0.9862879  1.76326753 0.44704368 1.28342341
 1.91457064 1.01476883 1.14073258 1.02208023 0.75850361 0.89687605
 0.89454052 1.35876298 1.97554069 1.14319113 0.60370645 0.89279613
 0.61835224 1.633395  1.01236044 1.04674566 1.76525404 1.2642542
 1.20646248 0.81912474 0.42556335 0.62984245 0.68863812 0.05099329
 2.06687781 0.34306778 0.98979083]
1925261.1560010156

```

```

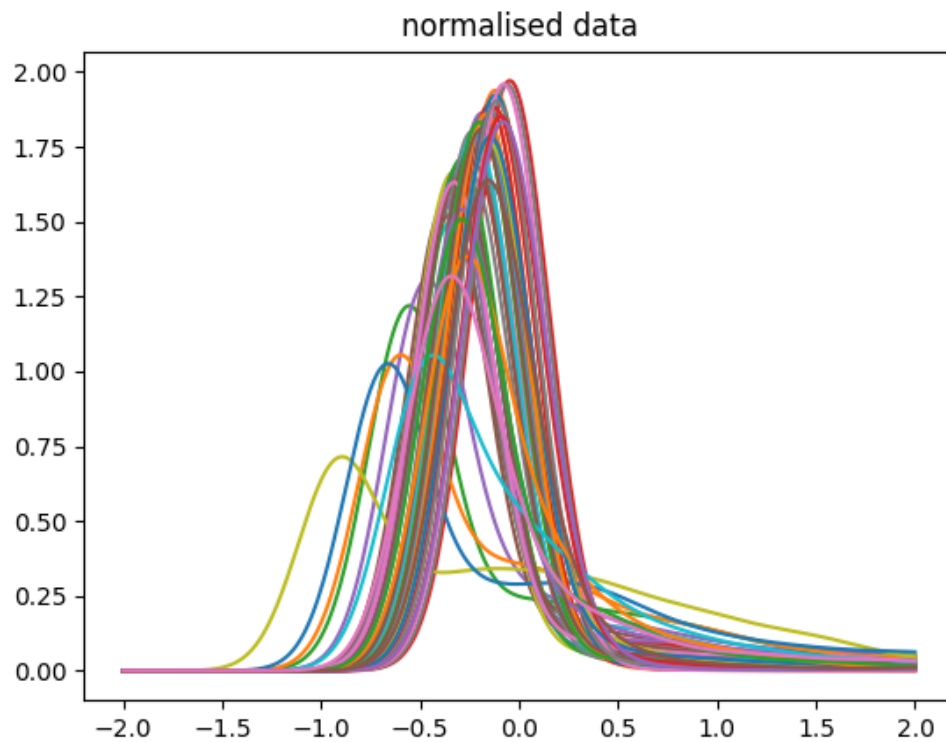
[283]: nextplot()
densities = [scipy.stats.gaussian_kde(Xz[:, j]) for j in range(D)]
xs = np.linspace(-2, 2, 500) # changing the x axis scale: most of the density
    ↪ is between 0 and 0.4
for j in range(D):
    plt.plot(xs, densities[j](xs)) # or features[j]
#plt.legend(ncol=5)
plt.title('normalised data')

```

```

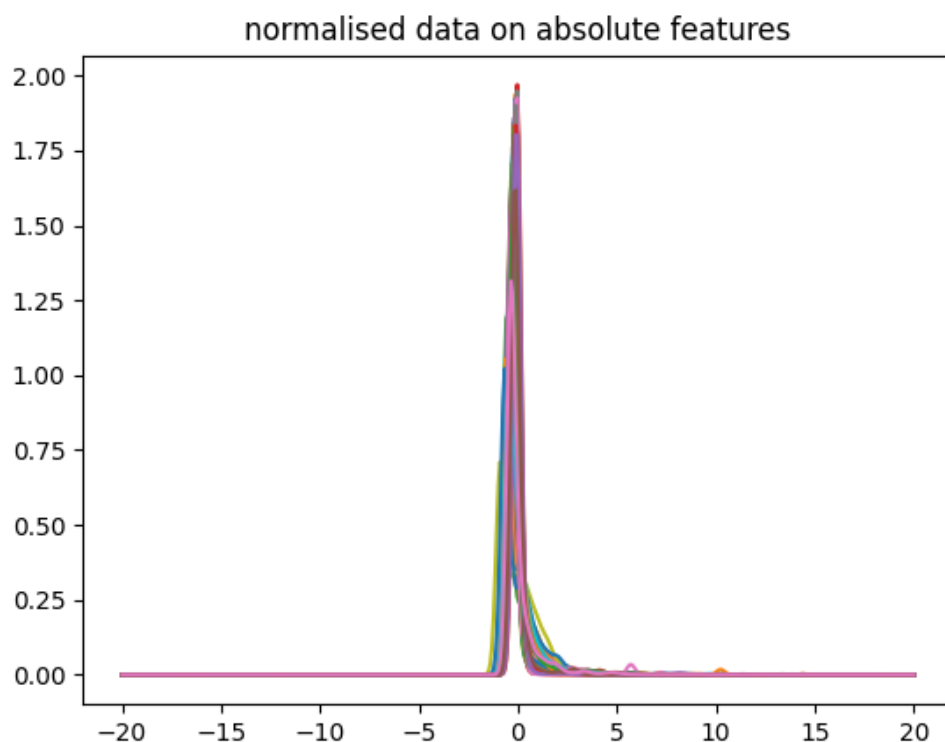
[283]: Text(0.5, 1.0, 'normalised data')

```



```
[284]: nextplot()
densities = [scipy.stats.gaussian_kde(Xz[:, j]) for j in range(D)]
xs = np.linspace(-20, 20, 500)
for j in range(D):
    plt.plot(xs, densities[j](xs)) # or features[j]
#plt.legend(ncol=5)
plt.title('normalised data on absolute features')
```

```
[284]: Text(0.5, 1.0, 'normalised data on absolute features')
```



6 2. Maximum Likelihood Estimation

6.1 Helper functions

```
[285]: def logsumexp(x):
        """Computes  $\log(\sum(\exp(x)))$ .

        Uses offset trick to reduce risk of numeric over- or underflow. When  $x$  is a
        1D ndarray, computes logsumexp of its entries. When  $x$  is a 2D ndarray,
        computes logsumexp of each column.

        Keyword arguments:
         $x$  : a 1D or 2D ndarray
        """
        offset = np.max(x, axis=0)
        return offset + np.log(np.sum(np.exp(x - offset), axis=0))

[286]: # Define the logistic function. Make sure it operates on both scalars
        # and vectors.
        def sigma(x):
```



```

# For large positive x, np.exp(-x) approaches 0, so sigma(x) ~ 1.
# For large negative x, np.exp(-x) becomes very large, so sigma(x) ~ 0.
return np.where(x >= 0,
                 1 / (1 + np.exp(-x)),
                 np.exp(x) / (1 + np.exp(x)))

```

```

[287]: # this should give:
# [0.5, array([0.26894142, 0.5, 0.73105858])]
[sigma(0), sigma(np.array([-1, 0, 1]))]

```

```

[287]: [array(0.5), array([0.26894142, 0.5, 0.73105858])]

```

Logistic function

$$\log(\sigma(x)) = \log\left(\frac{1}{1 + e^{-x}}\right) = -\log(1 + e^{-x})$$

```

[288]: # Define the logarithm of the logistic function. Make sure it operates on both
# scalars and vectors. Perhaps helpful: isinstance(x, np.ndarray).
def logsigma(x):
    # Compute the log of the logistic function in a numerically stable way
    return np.where(
        x >= 0,
        -np.log1p(np.exp(-x)), # log(1 + exp(-x)) is stable for large positive x
        x - np.log1p(np.exp(x)) # x - log(1 + exp(x)) is stable for large negative x
    )

```

```

[289]: # this should give:
# [-0.69314718055994529, array([-1.31326169, -0.69314718, -0.31326169])]
[logsigma(0), logsigma(np.array([-1, 0, 1]))]

```

```

[289]: [array(-0.69314718), array([-1.31326169, -0.69314718, -0.31326169])]

```

6.2 2b Log-likelihood and gradient

$$\text{log-likelihood} = \sum_{i=1}^N (y_i \cdot \log(\sigma(X_i \cdot w)) + (1 - y_i) \cdot \log(1 - \sigma(X_i \cdot w)))$$

```

[290]: def l(y, X, w):
    """Log-likelihood of the logistic regression model.

    Parameters
    -----
    y : ndarray of shape (N,)
        Binary labels (either 0 or 1).
    X : ndarray of shape (N,D)

```

```

        Design matrix.
        w : ndarray of shape (D,)
        Weight vector.
        """
        # YOUR CODE HERE
        # Compute the linear combination X @ w once
        z = np.dot(X, w)

        # Use z and -z in logsigma, avoiding recomputation
        return np.sum(y * logsigma(z) + (1 - y) * logsigma(-z))

```

```

[291]: # this should give:
# -47066.641667825766
l(y, Xz, np.linspace(-5, 5, D))

```

```

[291]: np.float64(-47066.64166782577)

```

The gradient is calculated as

$$\frac{\partial l}{\partial w} = X^T \cdot (y - \sigma(X \cdot w))$$

```

[292]: def dl(y, X, w):
        """Gradient of the log-likelihood of the logistic regression model.

        Parameters
        -----
        y : ndarray of shape (N,)
            Binary labels (either 0 or 1).
        X : ndarray of shape (N,D)
            Design matrix.
        w : ndarray of shape (D,)
            Weight vector.

        Returns
        -----
        ndarray of shape (D,)
        """

        # YOUR CODE HERE
        # Compute the predicted probabilities
        predictions = sigma(np.dot(X, w))

        # Calculate the gradient as X.T @ (y - predictions)
        return np.dot(X.T, (y - predictions))

```

```

[293]: # this should give:
# array([ 551.33985842,  143.84116318,  841.83373606,  156.87237578,
#         802.61217579,  795.96202907,  920.69045803,  621.96516752,

```

```

#      659.18724769,    470.81259805,    771.32406968,    352.40325626,
#      455.66972482,    234.36600888,    562.45454038,    864.83981264,
#      787.19723703,    649.48042176,    902.6478154 ,    544.00539886,
#      1174.78638035,    120.3598967 ,    839.61141672,    633.30453444,
#      -706.66815087,   -630.2039816 ,   -569.3451386 ,   -527.50996698,
#      -359.53701083,   -476.64334832,   -411.60620464,   -375.11950586,
#      -345.37195689,   -376.22044258,   -407.31761977,   -456.23251936,
#      -596.86960184,   -107.97072355,   -394.82170044,   -229.18125598,
#      -288.46356547,   -362.13402385,   -450.87896465,   -277.03932676,
#      -414.99293368,   -452.28771693,   -167.54649092,   -270.9043748 ,
#      -252.20140951,   -357.72497343,   -259.12468742,    418.35938483,
#      604.54173228,     43.10390907,    152.24258478,    378.16731033,
#      416.12032881])
dl(y, Xz, np.linspace(-5, 5, D))

```

```

[293]: array([ 551.33985842,  143.84116318,  841.83373606,  156.87237578,
              802.61217579,  795.96202907,  920.69045803,  621.96516752,
              659.18724769,  470.81259805,  771.32406968,  352.40325626,
              455.66972482,  234.36600888,  562.45454038,  864.83981264,
              787.19723703,  649.48042176,  902.6478154 ,  544.00539886,
              1174.78638035,  120.3598967 ,  839.61141672,  633.30453444,
              -706.66815087, -630.2039816 , -569.3451386 , -527.50996698,
              -359.53701083, -476.64334832, -411.60620464, -375.11950586,
              -345.37195689, -376.22044258, -407.31761977, -456.23251936,
              -596.86960184, -107.97072355, -394.82170044, -229.18125598,
              -288.46356547, -362.13402385, -450.87896465, -277.03932676,
              -414.99293368, -452.28771693, -167.54649092, -270.9043748 ,
              -252.20140951, -357.72497343, -259.12468742,  418.35938483,
              604.54173228,   43.10390907,  152.24258478,  378.16731033,
              416.12032881])

```

6.3 2c Gradient descent

```

[294]: # you don't need to modify this function
def optimize(obj_up, theta0, nepochs=50, eps0=0.01, verbose=True):
    """Iteratively minimize a function.

    We use it here to run either gradient descent or stochastic gradient
    descent, using arbitrarily optimization criteria.

    Parameters
    -----
    obj_up : a tuple of form (f, update) containing two functions f and update.
             f(theta) computes the value of the objective function.
             update(theta,eps) performs an epoch of parameter update with step_
    ↪size
             eps and returns the result.
    """

```

```

theta0 : ndarray of shape (D,)
        Initial parameter vector.
nepochs : int
        How many epochs (calls to update) to run.
eps0 : float
        Initial step size.
verbose : boolean
        Whether to print progress information.

Returns
-----
A triple consisting of the fitted parameter vector, the values of the
objective function after every epoch, and the step sizes that were used.
"""

f, update = obj_up

# initialize results
theta = theta0
values = np.zeros(nepochs + 1)
eps = np.zeros(nepochs + 1)
values[0] = f(theta0)
eps[0] = eps0

# now run the update function nepochs times
for epoch in range(nepochs):
    if verbose:
        print(
            "Epoch {:3d}: f={:10.3f}, eps={:10.9f}".format(
                epoch, values[epoch], eps[epoch]
            )
        )
    theta = update(theta, eps[epoch])

    # we use the bold driver heuristic
    values[epoch + 1] = f(theta)
    if values[epoch] < values[epoch + 1]:
        eps[epoch + 1] = eps[epoch] / 2.0
    else:
        eps[epoch + 1] = eps[epoch] * 1.05

# all done
if verbose:
    print("Result after {} epochs: f={}".format(nepochs, values[-1]))
return theta, values, eps

```

```
[295]: # define the objective and update function for one gradient-descent epoch for
# fitting an MLE estimate of logistic regression with gradient descent (should
# return a tuple of two functions; see optimize)
def gd(y, X):
    """Defines the objective and update functions for one gradient descent
    epoch
    to fit an MLE estimate of logistic regression.

    Parameters
    -----
    y : ndarray of shape (N,)
        Binary labels (either 0 or 1).
    X : ndarray of shape (N, D)
        Design matrix.

    Returns
    -----
    tuple
        A tuple containing:
        - objective: Function that computes the negative log-likelihood.
        - update: Function that updates weights with a single gradient descent
    step.
    """
    def objective(w):
        """Objective function: Negative log-likelihood of logistic regression.
        """
        return -l(y, X, w)

    def update(w, eps):
        """Update function: Performs a gradient descent step."""
        return w + eps * dl(y, X, w)

    return (objective, update)
```

```
[296]: # this should give
# [47066.641667825766,
# array([ 4.13777838e+01, -1.56745627e+01,  5.75882538e+01,
#         1.14225143e+01,  5.54249703e+01,  5.99229049e+01,
#         7.11220141e+01,  4.84761728e+01,  5.78067289e+01,
#         4.54794720e+01,  7.14638492e+01,  1.51369386e+01,
#         3.36375739e+01,  2.15061217e+01,  5.78014255e+01,
#         6.72743066e+01,  7.00829312e+01,  5.29328088e+01,
#         6.16042473e+01,  5.50018510e+01,  8.94624817e+01,
#         2.74784480e+01,  8.51763599e+01,  5.60363965e+01,
#        -2.55865589e+01, -1.53788213e+01, -4.67015412e+01,
#        -2.50356570e+00, -3.85357592e+00, -2.21819155e+00,
```

```

#          3.32098671e+00,   3.86933390e+00,  -2.00309898e+01,
#          3.84684492e+00,  -2.19847927e-01,  -1.29775457e+00,
#         -1.28374302e+01,  -2.78303173e+00,  -5.61671182e+00,
#          1.73657121e+01,  -6.81197570e+00,  -1.20249002e+01,
#          2.65789491e+00,  -1.39557852e+01,  -2.01135653e+01,
#         -2.72134051e+01,  -9.45952961e-01,  -1.02239111e+01,
#          1.52794293e-04,  -5.18938123e-01,  -3.19717561e+00,
#          4.62953437e+01,   7.87893022e+01,   1.88618651e+01,
#          2.85195027e+01,   5.04698358e+01,   6.41240689e+01])
f, update = gd(y, Xz)
[f(np.linspace(-5, 5, D)), update(np.linspace(-5, -5, D), 0.1)]

```

```

[296]: [np.float64(47066.64166782577),
array([ 4.13777838e+01, -1.56745627e+01,  5.75882538e+01,  1.14225143e+01,
        5.54249703e+01,  5.99229049e+01,  7.11220141e+01,  4.84761728e+01,
        5.78067289e+01,  4.54794720e+01,  7.14638492e+01,  1.51369386e+01,
        3.36375739e+01,  2.15061217e+01,  5.78014255e+01,  6.72743066e+01,
        7.00829312e+01,  5.29328088e+01,  6.16042473e+01,  5.50018510e+01,
        8.94624817e+01,  2.74784480e+01,  8.51763599e+01,  5.60363965e+01,
       -2.55865589e+01, -1.53788213e+01, -4.67015412e+01, -2.50356570e+00,
       -3.85357592e+00, -2.21819155e+00,  3.32098671e+00,  3.86933390e+00,
       -2.00309898e+01,  3.84684492e+00, -2.19847927e-01, -1.29775457e+00,
       -1.28374302e+01, -2.78303173e+00, -5.61671182e+00,  1.73657121e+01,
       -6.81197570e+00, -1.20249002e+01,  2.65789491e+00, -1.39557852e+01,
       -2.01135653e+01, -2.72134051e+01, -9.45952961e-01, -1.02239111e+01,
        1.52794293e-04, -5.18938123e-01, -3.19717561e+00,  4.62953437e+01,
        7.87893022e+01,  1.88618651e+01,  2.85195027e+01,  5.04698358e+01,
        6.41240689e+01])])

```

```

[297]: # you can run gradient descent!
numpy.random.seed(0)
w0 = np.random.normal(size=D)
wz_gd, vz_gd, ez_gd = optimize(gd(y, Xz), w0, nepochs=500)

```

```

Epoch 0: f= 6636.208, eps=0.010000000
Epoch 1: f= 4216.957, eps=0.010500000
Epoch 2: f= 2657.519, eps=0.011025000
Epoch 3: f= 1926.135, eps=0.011576250
Epoch 4: f= 1449.495, eps=0.012155063
Epoch 5: f= 1207.529, eps=0.012762816
Epoch 6: f= 1052.489, eps=0.013400956
Epoch 7: f= 957.275, eps=0.014071004
Epoch 8: f= 899.610, eps=0.014774554
Epoch 9: f= 882.904, eps=0.015513282
Epoch 10: f= 1017.083, eps=0.007756641
Epoch 11: f= 840.760, eps=0.008144473
Epoch 12: f= 805.649, eps=0.008551697

```

Epoch	13:	f=	822.108,	eps=0.004275848
Epoch	14:	f=	746.377,	eps=0.004489641
Epoch	15:	f=	735.803,	eps=0.004714123
Epoch	16:	f=	729.780,	eps=0.004949829
Epoch	17:	f=	724.467,	eps=0.005197320
Epoch	18:	f=	719.408,	eps=0.005457186
Epoch	19:	f=	714.564,	eps=0.005730046
Epoch	20:	f=	709.932,	eps=0.006016548
Epoch	21:	f=	705.514,	eps=0.006317375
Epoch	22:	f=	701.321,	eps=0.006633244
Epoch	23:	f=	697.373,	eps=0.006964906
Epoch	24:	f=	693.728,	eps=0.007313152
Epoch	25:	f=	690.591,	eps=0.007678809
Epoch	26:	f=	688.614,	eps=0.008062750
Epoch	27:	f=	688.607,	eps=0.008465887
Epoch	28:	f=	690.854,	eps=0.004232944
Epoch	29:	f=	679.967,	eps=0.004444591
Epoch	30:	f=	678.649,	eps=0.004666820
Epoch	31:	f=	677.447,	eps=0.004900161
Epoch	32:	f=	676.292,	eps=0.005145169
Epoch	33:	f=	675.182,	eps=0.005402428
Epoch	34:	f=	674.120,	eps=0.005672549
Epoch	35:	f=	673.114,	eps=0.005956177
Epoch	36:	f=	672.177,	eps=0.006253986
Epoch	37:	f=	671.334,	eps=0.006566685
Epoch	38:	f=	670.656,	eps=0.006895019
Epoch	39:	f=	670.397,	eps=0.007239770
Epoch	40:	f=	671.342,	eps=0.003619885
Epoch	41:	f=	668.932,	eps=0.003800879
Epoch	42:	f=	668.378,	eps=0.003990923
Epoch	43:	f=	668.027,	eps=0.004190469
Epoch	44:	f=	667.720,	eps=0.004399993
Epoch	45:	f=	667.433,	eps=0.004619993
Epoch	46:	f=	667.159,	eps=0.004850992
Epoch	47:	f=	666.897,	eps=0.005093542
Epoch	48:	f=	666.650,	eps=0.005348219
Epoch	49:	f=	666.417,	eps=0.005615630
Epoch	50:	f=	666.201,	eps=0.005896411
Epoch	51:	f=	666.008,	eps=0.006191232
Epoch	52:	f=	665.858,	eps=0.006500794
Epoch	53:	f=	665.812,	eps=0.006825833
Epoch	54:	f=	666.068,	eps=0.003412917
Epoch	55:	f=	665.424,	eps=0.003583562
Epoch	56:	f=	665.290,	eps=0.003762741
Epoch	57:	f=	665.204,	eps=0.003950878
Epoch	58:	f=	665.128,	eps=0.004148421
Epoch	59:	f=	665.054,	eps=0.004355843
Epoch	60:	f=	664.982,	eps=0.004573635

Epoch	61:	f=	664.911,	eps=0.004802316
Epoch	62:	f=	664.842,	eps=0.005042432
Epoch	63:	f=	664.773,	eps=0.005294554
Epoch	64:	f=	664.707,	eps=0.005559282
Epoch	65:	f=	664.641,	eps=0.005837246
Epoch	66:	f=	664.578,	eps=0.006129108
Epoch	67:	f=	664.518,	eps=0.006435563
Epoch	68:	f=	664.467,	eps=0.006757341
Epoch	69:	f=	664.446,	eps=0.007095208
Epoch	70:	f=	664.544,	eps=0.003547604
Epoch	71:	f=	664.339,	eps=0.003724984
Epoch	72:	f=	664.278,	eps=0.003911234
Epoch	73:	f=	664.239,	eps=0.004106795
Epoch	74:	f=	664.206,	eps=0.004312135
Epoch	75:	f=	664.173,	eps=0.004527742
Epoch	76:	f=	664.139,	eps=0.004754129
Epoch	77:	f=	664.106,	eps=0.004991835
Epoch	78:	f=	664.072,	eps=0.005241427
Epoch	79:	f=	664.037,	eps=0.005503499
Epoch	80:	f=	664.002,	eps=0.005778674
Epoch	81:	f=	663.967,	eps=0.006067607
Epoch	82:	f=	663.936,	eps=0.006370988
Epoch	83:	f=	663.918,	eps=0.006689537
Epoch	84:	f=	663.948,	eps=0.003344768
Epoch	85:	f=	663.839,	eps=0.003512007
Epoch	86:	f=	663.807,	eps=0.003687607
Epoch	87:	f=	663.783,	eps=0.003871988
Epoch	88:	f=	663.760,	eps=0.004065587
Epoch	89:	f=	663.737,	eps=0.004268866
Epoch	90:	f=	663.713,	eps=0.004482310
Epoch	91:	f=	663.688,	eps=0.004706425
Epoch	92:	f=	663.661,	eps=0.004941746
Epoch	93:	f=	663.634,	eps=0.005188834
Epoch	94:	f=	663.606,	eps=0.005448275
Epoch	95:	f=	663.576,	eps=0.005720689
Epoch	96:	f=	663.546,	eps=0.006006724
Epoch	97:	f=	663.514,	eps=0.006307060
Epoch	98:	f=	663.482,	eps=0.006622413
Epoch	99:	f=	663.451,	eps=0.006953533
Epoch	100:	f=	663.427,	eps=0.007301210
Epoch	101:	f=	663.442,	eps=0.003650605
Epoch	102:	f=	663.371,	eps=0.003833135
Epoch	103:	f=	663.340,	eps=0.004024792
Epoch	104:	f=	663.316,	eps=0.004226032
Epoch	105:	f=	663.294,	eps=0.004437333
Epoch	106:	f=	663.271,	eps=0.004659200
Epoch	107:	f=	663.248,	eps=0.004892160
Epoch	108:	f=	663.223,	eps=0.005136768

Epoch 109: f= 663.198, eps=0.005393606
Epoch 110: f= 663.172, eps=0.005663287
Epoch 111: f= 663.146, eps=0.005946451
Epoch 112: f= 663.121, eps=0.006243773
Epoch 113: f= 663.102, eps=0.006555962
Epoch 114: f= 663.108, eps=0.003277981
Epoch 115: f= 663.042, eps=0.003441880
Epoch 116: f= 663.019, eps=0.003613974
Epoch 117: f= 663.001, eps=0.003794673
Epoch 118: f= 662.982, eps=0.003984406
Epoch 119: f= 662.963, eps=0.004183627
Epoch 120: f= 662.943, eps=0.004392808
Epoch 121: f= 662.922, eps=0.004612449
Epoch 122: f= 662.900, eps=0.004843071
Epoch 123: f= 662.877, eps=0.005085225
Epoch 124: f= 662.853, eps=0.005339486
Epoch 125: f= 662.828, eps=0.005606460
Epoch 126: f= 662.802, eps=0.005886783
Epoch 127: f= 662.774, eps=0.006181122
Epoch 128: f= 662.745, eps=0.006490178
Epoch 129: f= 662.715, eps=0.006814687
Epoch 130: f= 662.685, eps=0.007155422
Epoch 131: f= 662.659, eps=0.007513193
Epoch 132: f= 662.656, eps=0.007888852
Epoch 133: f= 662.786, eps=0.003944426
Epoch 134: f= 662.631, eps=0.004141647
Epoch 135: f= 662.578, eps=0.004348730
Epoch 136: f= 662.545, eps=0.004566166
Epoch 137: f= 662.519, eps=0.004794475
Epoch 138: f= 662.497, eps=0.005034198
Epoch 139: f= 662.477, eps=0.005285908
Epoch 140: f= 662.462, eps=0.005550204
Epoch 141: f= 662.457, eps=0.005827714
Epoch 142: f= 662.476, eps=0.002913857
Epoch 143: f= 662.373, eps=0.003059550
Epoch 144: f= 662.355, eps=0.003212527
Epoch 145: f= 662.340, eps=0.003373154
Epoch 146: f= 662.325, eps=0.003541811
Epoch 147: f= 662.310, eps=0.003718902
Epoch 148: f= 662.293, eps=0.003904847
Epoch 149: f= 662.276, eps=0.004100089
Epoch 150: f= 662.257, eps=0.004305094
Epoch 151: f= 662.238, eps=0.004520348
Epoch 152: f= 662.218, eps=0.004746366
Epoch 153: f= 662.197, eps=0.004983684
Epoch 154: f= 662.175, eps=0.005232868
Epoch 155: f= 662.152, eps=0.005494512
Epoch 156: f= 662.128, eps=0.005769237

Epoch 157: f= 662.103, eps=0.006057699
Epoch 158: f= 662.076, eps=0.006360584
Epoch 159: f= 662.048, eps=0.006678613
Epoch 160: f= 662.019, eps=0.007012544
Epoch 161: f= 661.989, eps=0.007363171
Epoch 162: f= 661.957, eps=0.007731330
Epoch 163: f= 661.924, eps=0.008117896
Epoch 164: f= 661.890, eps=0.008523791
Epoch 165: f= 661.859, eps=0.008949981
Epoch 166: f= 661.868, eps=0.004474990
Epoch 167: f= 661.834, eps=0.004698740
Epoch 168: f= 661.809, eps=0.004933677
Epoch 169: f= 661.791, eps=0.005180361
Epoch 170: f= 661.780, eps=0.005439379
Epoch 171: f= 661.784, eps=0.002719689
Epoch 172: f= 661.698, eps=0.002855674
Epoch 173: f= 661.685, eps=0.002998458
Epoch 174: f= 661.672, eps=0.003148380
Epoch 175: f= 661.659, eps=0.003305799
Epoch 176: f= 661.645, eps=0.003471089
Epoch 177: f= 661.630, eps=0.003644644
Epoch 178: f= 661.615, eps=0.003826876
Epoch 179: f= 661.599, eps=0.004018220
Epoch 180: f= 661.582, eps=0.004219131
Epoch 181: f= 661.564, eps=0.004430087
Epoch 182: f= 661.546, eps=0.004651592
Epoch 183: f= 661.526, eps=0.004884171
Epoch 184: f= 661.506, eps=0.005128380
Epoch 185: f= 661.485, eps=0.005384799
Epoch 186: f= 661.462, eps=0.005654039
Epoch 187: f= 661.439, eps=0.005936741
Epoch 188: f= 661.414, eps=0.006233578
Epoch 189: f= 661.388, eps=0.006545257
Epoch 190: f= 661.361, eps=0.006872520
Epoch 191: f= 661.333, eps=0.007216146
Epoch 192: f= 661.303, eps=0.007576953
Epoch 193: f= 661.272, eps=0.007955801
Epoch 194: f= 661.240, eps=0.008353591
Epoch 195: f= 661.206, eps=0.008771270
Epoch 196: f= 661.170, eps=0.009209834
Epoch 197: f= 661.133, eps=0.009670325
Epoch 198: f= 661.097, eps=0.010153842
Epoch 199: f= 661.093, eps=0.010661534
Epoch 200: f= 661.463, eps=0.005330767
Epoch 201: f= 661.555, eps=0.002665383
Epoch 202: f= 660.978, eps=0.002798653
Epoch 203: f= 660.966, eps=0.002938585
Epoch 204: f= 660.955, eps=0.003085514

Epoch 205: f= 660.942, eps=0.003239790
Epoch 206: f= 660.929, eps=0.003401780
Epoch 207: f= 660.916, eps=0.003571869
Epoch 208: f= 660.902, eps=0.003750462
Epoch 209: f= 660.887, eps=0.003937985
Epoch 210: f= 660.871, eps=0.004134885
Epoch 211: f= 660.855, eps=0.004341629
Epoch 212: f= 660.837, eps=0.004558710
Epoch 213: f= 660.819, eps=0.004786646
Epoch 214: f= 660.801, eps=0.005025978
Epoch 215: f= 660.781, eps=0.005277277
Epoch 216: f= 660.760, eps=0.005541141
Epoch 217: f= 660.738, eps=0.005818198
Epoch 218: f= 660.715, eps=0.006109108
Epoch 219: f= 660.691, eps=0.006414563
Epoch 220: f= 660.666, eps=0.006735291
Epoch 221: f= 660.640, eps=0.007072056
Epoch 222: f= 660.612, eps=0.007425659
Epoch 223: f= 660.583, eps=0.007796941
Epoch 224: f= 660.553, eps=0.008186788
Epoch 225: f= 660.521, eps=0.008596128
Epoch 226: f= 660.488, eps=0.009025934
Epoch 227: f= 660.453, eps=0.009477231
Epoch 228: f= 660.417, eps=0.009951093
Epoch 229: f= 660.379, eps=0.010448647
Epoch 230: f= 660.344, eps=0.010971080
Epoch 231: f= 660.362, eps=0.005485540
Epoch 232: f= 660.377, eps=0.002742770
Epoch 233: f= 660.267, eps=0.002879908
Epoch 234: f= 660.254, eps=0.003023904
Epoch 235: f= 660.243, eps=0.003175099
Epoch 236: f= 660.231, eps=0.003333854
Epoch 237: f= 660.218, eps=0.003500547
Epoch 238: f= 660.205, eps=0.003675574
Epoch 239: f= 660.191, eps=0.003859353
Epoch 240: f= 660.176, eps=0.004052320
Epoch 241: f= 660.161, eps=0.004254936
Epoch 242: f= 660.145, eps=0.004467683
Epoch 243: f= 660.128, eps=0.004691067
Epoch 244: f= 660.111, eps=0.004925621
Epoch 245: f= 660.092, eps=0.005171902
Epoch 246: f= 660.073, eps=0.005430497
Epoch 247: f= 660.052, eps=0.005702022
Epoch 248: f= 660.031, eps=0.005987123
Epoch 249: f= 660.009, eps=0.006286479
Epoch 250: f= 659.985, eps=0.006600803
Epoch 251: f= 659.961, eps=0.006930843
Epoch 252: f= 659.935, eps=0.007277385

Epoch 253: f= 659.908, eps=0.007641254
Epoch 254: f= 659.880, eps=0.008023317
Epoch 255: f= 659.850, eps=0.008424483
Epoch 256: f= 659.819, eps=0.008845707
Epoch 257: f= 659.787, eps=0.009287992
Epoch 258: f= 659.754, eps=0.009752392
Epoch 259: f= 659.737, eps=0.010240012
Epoch 260: f= 659.888, eps=0.005120006
Epoch 261: f= 659.906, eps=0.002560003
Epoch 262: f= 659.651, eps=0.002688003
Epoch 263: f= 659.641, eps=0.002822403
Epoch 264: f= 659.631, eps=0.002963523
Epoch 265: f= 659.620, eps=0.003111700
Epoch 266: f= 659.609, eps=0.003267285
Epoch 267: f= 659.597, eps=0.003430649
Epoch 268: f= 659.585, eps=0.003602181
Epoch 269: f= 659.572, eps=0.003782290
Epoch 270: f= 659.558, eps=0.003971405
Epoch 271: f= 659.543, eps=0.004169975
Epoch 272: f= 659.528, eps=0.004378474
Epoch 273: f= 659.513, eps=0.004597397
Epoch 274: f= 659.496, eps=0.004827267
Epoch 275: f= 659.479, eps=0.005068631
Epoch 276: f= 659.460, eps=0.005322062
Epoch 277: f= 659.441, eps=0.005588165
Epoch 278: f= 659.421, eps=0.005867574
Epoch 279: f= 659.400, eps=0.006160952
Epoch 280: f= 659.378, eps=0.006469000
Epoch 281: f= 659.355, eps=0.006792450
Epoch 282: f= 659.331, eps=0.007132072
Epoch 283: f= 659.305, eps=0.007488676
Epoch 284: f= 659.279, eps=0.007863110
Epoch 285: f= 659.251, eps=0.008256265
Epoch 286: f= 659.222, eps=0.008669078
Epoch 287: f= 659.191, eps=0.009102532
Epoch 288: f= 659.159, eps=0.009557659
Epoch 289: f= 659.125, eps=0.010035542
Epoch 290: f= 659.090, eps=0.010537319
Epoch 291: f= 659.053, eps=0.011064185
Epoch 292: f= 659.016, eps=0.011617394
Epoch 293: f= 658.992, eps=0.012198264
Epoch 294: f= 659.226, eps=0.006099132
Epoch 295: f= 659.526, eps=0.003049566
Epoch 296: f= 658.916, eps=0.003202044
Epoch 297: f= 658.891, eps=0.003362147
Epoch 298: f= 658.878, eps=0.003530254
Epoch 299: f= 658.865, eps=0.003706767
Epoch 300: f= 658.852, eps=0.003892105

Epoch 301: f= 658.839, eps=0.004086710
Epoch 302: f= 658.825, eps=0.004291046
Epoch 303: f= 658.810, eps=0.004505598
Epoch 304: f= 658.795, eps=0.004730878
Epoch 305: f= 658.778, eps=0.004967422
Epoch 306: f= 658.761, eps=0.005215793
Epoch 307: f= 658.743, eps=0.005476582
Epoch 308: f= 658.725, eps=0.005750412
Epoch 309: f= 658.705, eps=0.006037932
Epoch 310: f= 658.684, eps=0.006339829
Epoch 311: f= 658.663, eps=0.006656820
Epoch 312: f= 658.640, eps=0.006989661
Epoch 313: f= 658.617, eps=0.007339144
Epoch 314: f= 658.593, eps=0.007706101
Epoch 315: f= 658.573, eps=0.008091406
Epoch 316: f= 658.582, eps=0.004045703
Epoch 317: f= 658.544, eps=0.004247988
Epoch 318: f= 658.521, eps=0.004460388
Epoch 319: f= 658.503, eps=0.004683407
Epoch 320: f= 658.486, eps=0.004917578
Epoch 321: f= 658.470, eps=0.005163456
Epoch 322: f= 658.455, eps=0.005421629
Epoch 323: f= 658.443, eps=0.005692711
Epoch 324: f= 658.436, eps=0.005977346
Epoch 325: f= 658.450, eps=0.002988673
Epoch 326: f= 658.381, eps=0.003138107
Epoch 327: f= 658.368, eps=0.003295012
Epoch 328: f= 658.356, eps=0.003459763
Epoch 329: f= 658.345, eps=0.003632751
Epoch 330: f= 658.333, eps=0.003814388
Epoch 331: f= 658.320, eps=0.004005108
Epoch 332: f= 658.307, eps=0.004205363
Epoch 333: f= 658.293, eps=0.004415631
Epoch 334: f= 658.278, eps=0.004636413
Epoch 335: f= 658.263, eps=0.004868234
Epoch 336: f= 658.247, eps=0.005111645
Epoch 337: f= 658.230, eps=0.005367228
Epoch 338: f= 658.212, eps=0.005635589
Epoch 339: f= 658.193, eps=0.005917368
Epoch 340: f= 658.174, eps=0.006213237
Epoch 341: f= 658.153, eps=0.006523899
Epoch 342: f= 658.132, eps=0.006850094
Epoch 343: f= 658.109, eps=0.007192598
Epoch 344: f= 658.086, eps=0.007552228
Epoch 345: f= 658.061, eps=0.007929840
Epoch 346: f= 658.036, eps=0.008326332
Epoch 347: f= 658.017, eps=0.008742648
Epoch 348: f= 658.040, eps=0.004371324

Epoch 349: f= 658.004, eps=0.004589890
Epoch 350: f= 657.981, eps=0.004819385
Epoch 351: f= 657.965, eps=0.005060354
Epoch 352: f= 657.954, eps=0.005313372
Epoch 353: f= 657.953, eps=0.005579040
Epoch 354: f= 657.969, eps=0.002789520
Epoch 355: f= 657.876, eps=0.002928996
Epoch 356: f= 657.864, eps=0.003075446
Epoch 357: f= 657.854, eps=0.003229218
Epoch 358: f= 657.844, eps=0.003390679
Epoch 359: f= 657.833, eps=0.003560213
Epoch 360: f= 657.821, eps=0.003738224
Epoch 361: f= 657.809, eps=0.003925135
Epoch 362: f= 657.797, eps=0.004121392
Epoch 363: f= 657.783, eps=0.004327461
Epoch 364: f= 657.770, eps=0.004543834
Epoch 365: f= 657.755, eps=0.004771026
Epoch 366: f= 657.740, eps=0.005009577
Epoch 367: f= 657.724, eps=0.005260056
Epoch 368: f= 657.707, eps=0.005523059
Epoch 369: f= 657.689, eps=0.005799212
Epoch 370: f= 657.671, eps=0.006089173
Epoch 371: f= 657.651, eps=0.006393631
Epoch 372: f= 657.631, eps=0.006713313
Epoch 373: f= 657.609, eps=0.007048978
Epoch 374: f= 657.587, eps=0.007401427
Epoch 375: f= 657.564, eps=0.007771499
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Epoch 377: f= 657.513, eps=0.008568077
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Epoch 383: f= 657.567, eps=0.002603638
Epoch 384: f= 657.357, eps=0.002733820
Epoch 385: f= 657.348, eps=0.002870511
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Epoch 387: f= 657.330, eps=0.003164738
Epoch 388: f= 657.320, eps=0.003322975
Epoch 389: f= 657.310, eps=0.003489124
Epoch 390: f= 657.299, eps=0.003663580
Epoch 391: f= 657.287, eps=0.003846759
Epoch 392: f= 657.275, eps=0.004039097
Epoch 393: f= 657.263, eps=0.004241052
Epoch 394: f= 657.250, eps=0.004453104
Epoch 395: f= 657.236, eps=0.004675760
Epoch 396: f= 657.221, eps=0.004909548

Epoch 397: f= 657.206, eps=0.005155025
Epoch 398: f= 657.190, eps=0.005412776
Epoch 399: f= 657.173, eps=0.005683415
Epoch 400: f= 657.156, eps=0.005967586
Epoch 401: f= 657.138, eps=0.006265965
Epoch 402: f= 657.118, eps=0.006579263
Epoch 403: f= 657.098, eps=0.006908226
Epoch 404: f= 657.077, eps=0.007253638
Epoch 405: f= 657.054, eps=0.007616320
Epoch 406: f= 657.031, eps=0.007997136
Epoch 407: f= 657.007, eps=0.008396992
Epoch 408: f= 656.981, eps=0.008816842
Epoch 409: f= 656.954, eps=0.009257684
Epoch 410: f= 656.926, eps=0.009720568
Epoch 411: f= 656.896, eps=0.010206597
Epoch 412: f= 656.866, eps=0.010716927
Epoch 413: f= 656.838, eps=0.011252773
Epoch 414: f= 656.871, eps=0.005626387
Epoch 415: f= 656.908, eps=0.002813193
Epoch 416: f= 656.776, eps=0.002953853
Epoch 417: f= 656.765, eps=0.003101546
Epoch 418: f= 656.755, eps=0.003256623
Epoch 419: f= 656.745, eps=0.003419454
Epoch 420: f= 656.735, eps=0.003590427
Epoch 421: f= 656.724, eps=0.003769948
Epoch 422: f= 656.713, eps=0.003958445
Epoch 423: f= 656.701, eps=0.004156368
Epoch 424: f= 656.689, eps=0.004364186
Epoch 425: f= 656.676, eps=0.004582395
Epoch 426: f= 656.662, eps=0.004811515
Epoch 427: f= 656.648, eps=0.005052091
Epoch 428: f= 656.632, eps=0.005304695
Epoch 429: f= 656.617, eps=0.005569930
Epoch 430: f= 656.600, eps=0.005848427
Epoch 431: f= 656.583, eps=0.006140848
Epoch 432: f= 656.564, eps=0.006447890
Epoch 433: f= 656.545, eps=0.006770285
Epoch 434: f= 656.525, eps=0.007108799
Epoch 435: f= 656.504, eps=0.007464239
Epoch 436: f= 656.482, eps=0.007837451
Epoch 437: f= 656.459, eps=0.008229324
Epoch 438: f= 656.435, eps=0.008640790
Epoch 439: f= 656.410, eps=0.009072829
Epoch 440: f= 656.388, eps=0.009526471
Epoch 441: f= 656.406, eps=0.004763235
Epoch 442: f= 656.387, eps=0.005001397
Epoch 443: f= 656.379, eps=0.005251467
Epoch 444: f= 656.381, eps=0.002625734

Epoch 445: f= 656.303, eps=0.002757020
Epoch 446: f= 656.295, eps=0.002894871
Epoch 447: f= 656.286, eps=0.003039615
Epoch 448: f= 656.277, eps=0.003191596
Epoch 449: f= 656.268, eps=0.003351175
Epoch 450: f= 656.258, eps=0.003518734
Epoch 451: f= 656.248, eps=0.003694671
Epoch 452: f= 656.237, eps=0.003879404
Epoch 453: f= 656.226, eps=0.004073375
Epoch 454: f= 656.214, eps=0.004277043
Epoch 455: f= 656.202, eps=0.004490895
Epoch 456: f= 656.189, eps=0.004715440
Epoch 457: f= 656.175, eps=0.004951212
Epoch 458: f= 656.161, eps=0.005198773
Epoch 459: f= 656.145, eps=0.005458711
Epoch 460: f= 656.130, eps=0.005731647
Epoch 461: f= 656.113, eps=0.006018229
Epoch 462: f= 656.096, eps=0.006319141
Epoch 463: f= 656.077, eps=0.006635098
Epoch 464: f= 656.058, eps=0.006966853
Epoch 465: f= 656.038, eps=0.007315195
Epoch 466: f= 656.017, eps=0.007680955
Epoch 467: f= 655.995, eps=0.008065003
Epoch 468: f= 655.972, eps=0.008468253
Epoch 469: f= 655.948, eps=0.008891666
Epoch 470: f= 655.923, eps=0.009336249
Epoch 471: f= 655.896, eps=0.009803061
Epoch 472: f= 655.868, eps=0.010293215
Epoch 473: f= 655.841, eps=0.010807875
Epoch 474: f= 655.835, eps=0.011348269
Epoch 475: f= 656.135, eps=0.005674135
Epoch 476: f= 656.301, eps=0.002837067
Epoch 477: f= 655.760, eps=0.002978921
Epoch 478: f= 655.744, eps=0.003127867
Epoch 479: f= 655.735, eps=0.003284260
Epoch 480: f= 655.725, eps=0.003448473
Epoch 481: f= 655.716, eps=0.003620897
Epoch 482: f= 655.705, eps=0.003801941
Epoch 483: f= 655.695, eps=0.003992039
Epoch 484: f= 655.684, eps=0.004191640
Epoch 485: f= 655.672, eps=0.004401222
Epoch 486: f= 655.659, eps=0.004621284
Epoch 487: f= 655.646, eps=0.004852348
Epoch 488: f= 655.633, eps=0.005094965
Epoch 489: f= 655.619, eps=0.005349713
Epoch 490: f= 655.604, eps=0.005617199
Epoch 491: f= 655.588, eps=0.005898059
Epoch 492: f= 655.571, eps=0.006192962


```
Epoch 493: f= 655.554, eps=0.006502610
Epoch 494: f= 655.536, eps=0.006827741
Epoch 495: f= 655.517, eps=0.007169128
Epoch 496: f= 655.497, eps=0.007527584
Epoch 497: f= 655.476, eps=0.007903963
Epoch 498: f= 655.454, eps=0.008299161
Epoch 499: f= 655.432, eps=0.008714119
Result after 500 epochs: f=655.413496469947
```

```
[298]: # Visualize the progress of gradient descent for vz_gd, wz_gd, and ez_gd

fig, axes = plt.subplots(2, 2, figsize=(12, 8)) # Create a 2x2 grid for
↳subplots

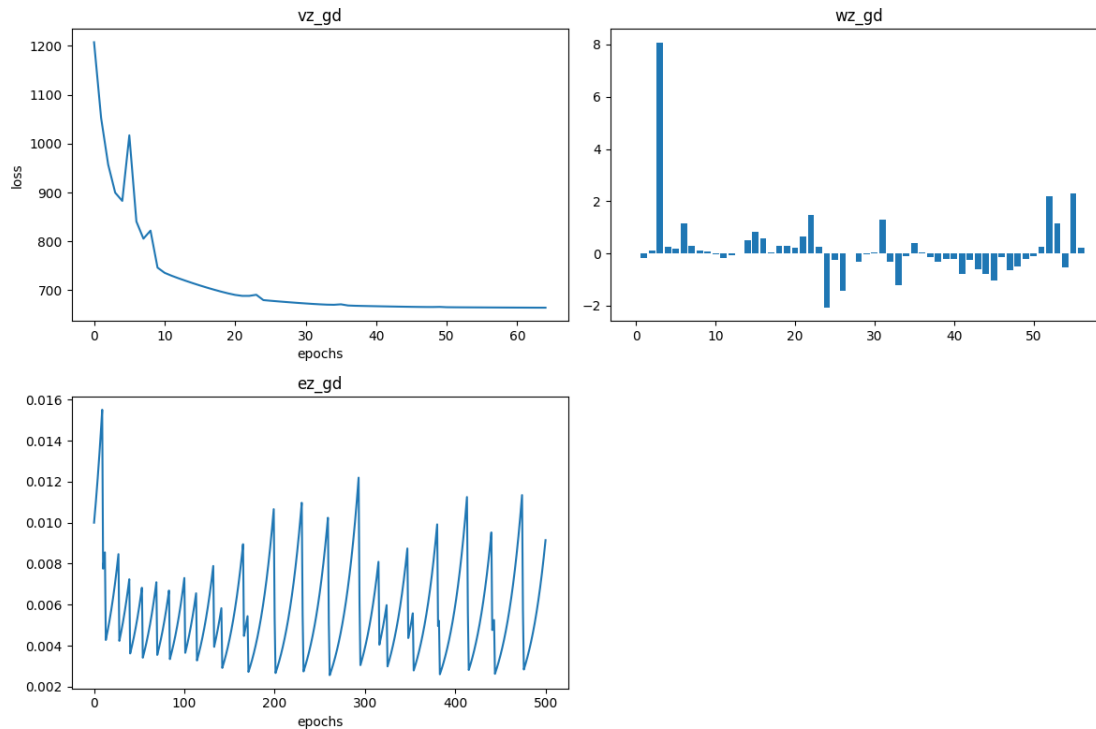
# Plot vz_gd progress
axes[0, 0].plot(vz_gd[5:70])
axes[0, 0].set_xlabel('epochs')
axes[0, 0].set_ylabel('loss')
axes[0, 0].set_title('vz_gd')

# Plot wz_gd as a bar chart
axes[0, 1].bar(range(len(wz_gd)), wz_gd)
axes[0, 1].set_title('wz_gd')

# Plot ez_gd convergence
axes[1, 0].plot(ez_gd)
axes[1, 0].set_xlabel('epochs')
axes[1, 0].set_title('ez_gd')

# Hide the unused subplot (bottom-right)
axes[1, 1].axis('off')

plt.tight_layout() # Adjust spacing between plots
plt.show()
```



6.4 2d Stochastic gradient descent

```
[299]: def sgdePOCH(y, X, w, eps):
    """Run one SGD epoch and return the updated weight vector. """
    # Run N stochastic gradient steps (without replacement). Do not rescale each
    # step by factor N (i.e., proceed differently than in the lecture slides).
    # YOUR CODE HERE
    # Shuffle indices for stochastic updates
    for i in np.random.permutation(len(X)):
        # Store the feature vector of the i-th sample
        xi = X[i]
        # Update weights with the stochastic gradient
        w = w + eps * (y[i] - sigma(np.dot(w, xi))) * xi
    return w
```

```
[300]: # when you run this multiple times, with 50% probability you should get the
# following result (there is one other result which is very close):
# array([-3.43689655e+02, -1.71161311e+02, -5.71093536e+02,
#        -5.16478220e+01,  4.66294348e+02, -3.71589878e+02,
#         5.21493183e+02,  1.25699230e+03,  8.33804130e+02,
#         5.63185399e+02,  1.32761302e+03, -2.64104011e+02,
#         7.10693307e+02, -1.75497331e+02, -1.94174427e+02,
#         1.11641507e+02, -3.30817509e+02, -3.46754913e+02,
```

```
#      8.48722111e+02, -1.89136304e+02, -4.25693844e+02,
#      -1.23084189e+02, -2.95894797e+02, -2.35789333e+02,
#      -3.38695243e+02, -3.05642830e+02, -2.28975383e+02,
#      -2.38075137e+02, -1.66702530e+02, -2.27341599e+02,
#      -1.77575620e+02, -1.49093855e+02, -1.70028859e+02,
#      -1.50243833e+02, -1.82986008e+02, -2.41143708e+02,
#      -3.31047159e+02, -5.79991185e+01, -1.98477863e+02,
#      -1.91264948e+02, -1.17371919e+02, -1.66953779e+02,
#      -2.01472565e+02, -1.23330949e+02, -3.00857740e+02,
#      -1.95853348e+02, -7.44868073e+01, -1.11172370e+02,
#      -1.57618226e+02, -1.25729512e+00, -1.45536466e+02,
#      -1.43362438e+02, -3.00429708e+02, -9.84391082e+01,
#      -4.54152047e+01, -5.26492232e+01, -1.45175427e+02])
sgdepoch(y[1:3], Xz[1:3, :], np.linspace(-5, 5, D), 1000)
```

```
/tmp/ipykernel_32055/4243986844.py:8: RuntimeWarning: overflow encountered in
exp
  np.exp(x) / (1 + np.exp(x)))
/tmp/ipykernel_32055/4243986844.py:8: RuntimeWarning: invalid value encountered
in scalar divide
  np.exp(x) / (1 + np.exp(x)))
```

```
[300]: array([-3.43689655e+02, -1.71161311e+02, -5.71093536e+02, -5.16478220e+01,
  4.66294348e+02, -3.71589878e+02,  5.21493183e+02,  1.25699230e+03,
  8.33804130e+02,  5.63185399e+02,  1.32761302e+03, -2.64104011e+02,
  7.10693307e+02, -1.75497331e+02, -1.94174427e+02,  1.11641507e+02,
 -3.30817509e+02, -3.46754913e+02,  8.48722111e+02, -1.89136304e+02,
 -4.25693844e+02, -1.23084189e+02, -2.95894797e+02, -2.35789333e+02,
 -3.38695243e+02, -3.05642830e+02, -2.28975383e+02, -2.38075137e+02,
 -1.66702530e+02, -2.27341599e+02, -1.77575620e+02, -1.49093855e+02,
 -1.70028859e+02, -1.50243833e+02, -1.82986008e+02, -2.41143708e+02,
 -3.31047159e+02, -5.79991185e+01, -1.98477863e+02, -1.91264948e+02,
 -1.17371919e+02, -1.66953779e+02, -2.01472565e+02, -1.23330949e+02,
 -3.00857740e+02, -1.95853348e+02, -7.44868073e+01, -1.11172370e+02,
 -1.57618226e+02, -1.25729512e+00, -1.45536466e+02, -1.43362438e+02,
 -3.00429708e+02, -9.84391082e+01, -4.54152047e+01, -5.26492232e+01,
 -1.45175427e+02])
```

```
[301]: # define the objective and update function for one gradient-descent epoch for
# fitting an MLE estimate of logistic regression with stochastic gradient
↪ descent
# (should return a tuple of two functions; see optimize)
def sgd(y, X):
    def objective(w):
        # YOUR CODE HERE
        """Objective function: Negative log-likelihood of logistic regression.
        ↪ """
```

```

    return -l(y, X, w)

def update(w, eps):
    return sgdepoch(y, X, w, eps)

return (objective, update)

```

```

[302]: # with 50% probability, you should get:
# [40.864973045695081,
# array([-3.43689655e+02, -1.71161311e+02, -5.71093536e+02,
#        -5.16478220e+01,  4.66294348e+02, -3.71589878e+02,
#        5.21493183e+02,  1.25699230e+03,  8.33804130e+02,
#        5.63185399e+02,  1.32761302e+03, -2.64104011e+02,
#        7.10693307e+02, -1.75497331e+02, -1.94174427e+02,
#        1.11641507e+02, -3.30817509e+02, -3.46754913e+02,
#        8.48722111e+02, -1.89136304e+02, -4.25693844e+02,
#       -1.23084189e+02, -2.95894797e+02, -2.35789333e+02,
#       -3.38695243e+02, -3.05642830e+02, -2.28975383e+02,
#       -2.38075137e+02, -1.66702530e+02, -2.27341599e+02,
#       -1.77575620e+02, -1.49093855e+02, -1.70028859e+02,
#       -1.50243833e+02, -1.82986008e+02, -2.41143708e+02,
#       -3.31047159e+02, -5.79991185e+01, -1.98477863e+02,
#       -1.91264948e+02, -1.17371919e+02, -1.66953779e+02,
#       -2.01472565e+02, -1.23330949e+02, -3.00857740e+02,
#       -1.95853348e+02, -7.44868073e+01, -1.11172370e+02,
#       -1.57618226e+02, -1.25729512e+00, -1.45536466e+02,
#       -1.43362438e+02, -3.00429708e+02, -9.84391082e+01,
#       -4.54152047e+01, -5.26492232e+01, -1.45175427e+02]])]
f, update = sg(y[1:3], Xz[1:3, :])
[f(np.linspace(-5, 5, D)), update(np.linspace(-5, 5, D), 1000)]

```

```

/tmp/ipykernel_32055/4243986844.py:8: RuntimeWarning: overflow encountered in
exp
    np.exp(x) / (1 + np.exp(x)))
/tmp/ipykernel_32055/4243986844.py:8: RuntimeWarning: invalid value encountered
in scalar divide
    np.exp(x) / (1 + np.exp(x)))

```

```

[302]: [np.float64(40.864973045695095),
array([-3.43689655e+02, -1.71161311e+02, -5.71093536e+02, -5.16478220e+01,
        4.66294348e+02, -3.71589878e+02,  5.21493183e+02,  1.25699230e+03,
        8.33804130e+02,  5.63185399e+02,  1.32761302e+03, -2.64104011e+02,
        7.10693307e+02, -1.75497331e+02, -1.94174427e+02,  1.11641507e+02,
       -3.30817509e+02, -3.46754913e+02,  8.48722111e+02, -1.89136304e+02,
       -4.25693844e+02, -1.23084189e+02, -2.95894797e+02, -2.35789333e+02,
       -3.38695243e+02, -3.05642830e+02, -2.28975383e+02, -2.38075137e+02,
       -1.66702530e+02, -2.27341599e+02, -1.77575620e+02, -1.49093855e+02,

```

```
-1.70028859e+02, -1.50243833e+02, -1.82986008e+02, -2.41143708e+02,
-3.31047159e+02, -5.79991185e+01, -1.98477863e+02, -1.91264948e+02,
-1.17371919e+02, -1.66953779e+02, -2.01472565e+02, -1.23330949e+02,
-3.00857740e+02, -1.95853348e+02, -7.44868073e+01, -1.11172370e+02,
-1.57618226e+02, -1.25729512e+00, -1.45536466e+02, -1.43362438e+02,
-3.00429708e+02, -9.84391082e+01, -4.54152047e+01, -5.26492232e+01,
-1.45175427e+02]]]
```

```
[303]: # you can run stochastic gradient descent!
wz_sgd, vz_sgd, ez_sgd = optimize(sgd(y, Xz), w0, nepochs=500)
```

```
Epoch 0: f= 6636.208, eps=0.010000000
Epoch 1: f= 958.654, eps=0.010500000
Epoch 2: f= 786.651, eps=0.011025000
Epoch 3: f= 738.739, eps=0.011576250
Epoch 4: f= 718.166, eps=0.012155063
Epoch 5: f= 709.413, eps=0.012762816
Epoch 6: f= 696.048, eps=0.013400956
Epoch 7: f= 701.674, eps=0.006700478
Epoch 8: f= 686.406, eps=0.007035502
Epoch 9: f= 683.692, eps=0.007387277
Epoch 10: f= 684.500, eps=0.003693639
Epoch 11: f= 679.969, eps=0.003878321
Epoch 12: f= 679.230, eps=0.004072237
Epoch 13: f= 678.181, eps=0.004275848
Epoch 14: f= 677.570, eps=0.004489641
Epoch 15: f= 676.763, eps=0.004714123
Epoch 16: f= 675.966, eps=0.004949829
Epoch 17: f= 676.625, eps=0.002474914
Epoch 18: f= 675.185, eps=0.002598660
Epoch 19: f= 674.531, eps=0.002728593
Epoch 20: f= 674.095, eps=0.002865023
Epoch 21: f= 673.692, eps=0.003008274
Epoch 22: f= 673.359, eps=0.003158688
Epoch 23: f= 673.075, eps=0.003316622
Epoch 24: f= 672.914, eps=0.003482453
Epoch 25: f= 672.549, eps=0.003656576
Epoch 26: f= 672.208, eps=0.003839405
Epoch 27: f= 672.128, eps=0.004031375
Epoch 28: f= 671.943, eps=0.004232944
Epoch 29: f= 671.364, eps=0.004444591
Epoch 30: f= 671.437, eps=0.002222295
Epoch 31: f= 670.780, eps=0.002333410
Epoch 32: f= 670.619, eps=0.002450081
Epoch 33: f= 670.405, eps=0.002572585
Epoch 34: f= 670.230, eps=0.002701214
Epoch 35: f= 670.065, eps=0.002836275
```

Epoch 36: f= 669.883, eps=0.002978088
 Epoch 37: f= 669.804, eps=0.003126993
 Epoch 38: f= 669.708, eps=0.003283342
 Epoch 39: f= 669.592, eps=0.003447510
 Epoch 40: f= 669.531, eps=0.003619885
 Epoch 41: f= 669.408, eps=0.003800879
 Epoch 42: f= 669.209, eps=0.003990923
 Epoch 43: f= 669.264, eps=0.001995462
 Epoch 44: f= 668.761, eps=0.002095235
 Epoch 45: f= 668.598, eps=0.002199996
 Epoch 46: f= 668.608, eps=0.001099998
 Epoch 47: f= 668.502, eps=0.001154998
 Epoch 48: f= 668.400, eps=0.001212748
 Epoch 49: f= 668.324, eps=0.001273385
 Epoch 50: f= 668.278, eps=0.001337055
 Epoch 51: f= 668.235, eps=0.001403907
 Epoch 52: f= 668.189, eps=0.001474103
 Epoch 53: f= 668.134, eps=0.001547808
 Epoch 54: f= 668.080, eps=0.001625198
 Epoch 55: f= 668.035, eps=0.001706458
 Epoch 56: f= 667.966, eps=0.001791781
 Epoch 57: f= 667.927, eps=0.001881370
 Epoch 58: f= 667.878, eps=0.001975439
 Epoch 59: f= 667.813, eps=0.002074211
 Epoch 60: f= 667.757, eps=0.002177921
 Epoch 61: f= 667.722, eps=0.002286817
 Epoch 62: f= 667.667, eps=0.002401158
 Epoch 63: f= 667.613, eps=0.002521216
 Epoch 64: f= 667.515, eps=0.002647277
 Epoch 65: f= 667.483, eps=0.002779641
 Epoch 66: f= 667.370, eps=0.002918623
 Epoch 67: f= 667.319, eps=0.003064554
 Epoch 68: f= 667.369, eps=0.001532277
 Epoch 69: f= 667.264, eps=0.001608891
 Epoch 70: f= 667.200, eps=0.001689335
 Epoch 71: f= 667.172, eps=0.001773802
 Epoch 72: f= 667.112, eps=0.001862492
 Epoch 73: f= 667.006, eps=0.001955617
 Epoch 74: f= 667.045, eps=0.000977808
 Epoch 75: f= 666.973, eps=0.001026699
 Epoch 76: f= 666.911, eps=0.001078034
 Epoch 77: f= 666.884, eps=0.001131935
 Epoch 78: f= 666.844, eps=0.001188532
 Epoch 79: f= 666.823, eps=0.001247959
 Epoch 80: f= 666.794, eps=0.001310357
 Epoch 81: f= 666.766, eps=0.001375875
 Epoch 82: f= 666.745, eps=0.001444668
 Epoch 83: f= 666.708, eps=0.001516902

Epoch 84: f= 666.707, eps=0.001592747
Epoch 85: f= 666.649, eps=0.001672384
Epoch 86: f= 666.632, eps=0.001756003
Epoch 87: f= 666.610, eps=0.001843804
Epoch 88: f= 666.579, eps=0.001935994
Epoch 89: f= 666.532, eps=0.002032793
Epoch 90: f= 666.482, eps=0.002134433
Epoch 91: f= 666.461, eps=0.002241155
Epoch 92: f= 666.440, eps=0.002353213
Epoch 93: f= 666.365, eps=0.002470873
Epoch 94: f= 666.433, eps=0.001235437
Epoch 95: f= 666.342, eps=0.001297208
Epoch 96: f= 666.294, eps=0.001362069
Epoch 97: f= 666.259, eps=0.001430172
Epoch 98: f= 666.240, eps=0.001501681
Epoch 99: f= 666.209, eps=0.001576765
Epoch 100: f= 666.185, eps=0.001655603
Epoch 101: f= 666.153, eps=0.001738383
Epoch 102: f= 666.153, eps=0.001825303
Epoch 103: f= 666.166, eps=0.000912651
Epoch 104: f= 666.137, eps=0.000958284
Epoch 105: f= 666.104, eps=0.001006198
Epoch 106: f= 666.091, eps=0.001056508
Epoch 107: f= 666.047, eps=0.001109333
Epoch 108: f= 666.025, eps=0.001164800
Epoch 109: f= 666.006, eps=0.001223040
Epoch 110: f= 665.992, eps=0.001284192
Epoch 111: f= 665.967, eps=0.001348402
Epoch 112: f= 665.966, eps=0.001415822
Epoch 113: f= 665.960, eps=0.001486613
Epoch 114: f= 665.916, eps=0.001560943
Epoch 115: f= 665.935, eps=0.000780472
Epoch 116: f= 665.913, eps=0.000819495
Epoch 117: f= 665.879, eps=0.000860470
Epoch 118: f= 665.865, eps=0.000903494
Epoch 119: f= 665.855, eps=0.000948668
Epoch 120: f= 665.834, eps=0.000996102
Epoch 121: f= 665.824, eps=0.001045907
Epoch 122: f= 665.811, eps=0.001098202
Epoch 123: f= 665.786, eps=0.001153112
Epoch 124: f= 665.777, eps=0.001210768
Epoch 125: f= 665.778, eps=0.000605384
Epoch 126: f= 665.761, eps=0.000635653
Epoch 127: f= 665.745, eps=0.000667436
Epoch 128: f= 665.737, eps=0.000700808
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Epoch 131: f= 665.704, eps=0.000811272

Epoch 132: f= 665.700, eps=0.000851836
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Epoch 134: f= 665.676, eps=0.000939149
Epoch 135: f= 665.662, eps=0.000986107
Epoch 136: f= 665.651, eps=0.001035412
Epoch 137: f= 665.640, eps=0.001087182
Epoch 138: f= 665.630, eps=0.001141542
Epoch 139: f= 665.614, eps=0.001198619
Epoch 140: f= 665.602, eps=0.001258550
Epoch 141: f= 665.586, eps=0.001321477
Epoch 142: f= 665.573, eps=0.001387551
Epoch 143: f= 665.570, eps=0.001456928
Epoch 144: f= 665.538, eps=0.001529775
Epoch 145: f= 665.519, eps=0.001606264
Epoch 146: f= 665.536, eps=0.000803132
Epoch 147: f= 665.500, eps=0.000843288
Epoch 148: f= 665.486, eps=0.000885453
Epoch 149: f= 665.471, eps=0.000929725
Epoch 150: f= 665.461, eps=0.000976212
Epoch 151: f= 665.451, eps=0.001025022
Epoch 152: f= 665.439, eps=0.001076273
Epoch 153: f= 665.432, eps=0.001130087
Epoch 154: f= 665.418, eps=0.001186591
Epoch 155: f= 665.420, eps=0.000593296
Epoch 156: f= 665.403, eps=0.000622961
Epoch 157: f= 665.393, eps=0.000654109
Epoch 158: f= 665.383, eps=0.000686814
Epoch 159: f= 665.376, eps=0.000721155
Epoch 160: f= 665.366, eps=0.000757212
Epoch 161: f= 665.357, eps=0.000795073
Epoch 162: f= 665.350, eps=0.000834827
Epoch 163: f= 665.344, eps=0.000876568
Epoch 164: f= 665.333, eps=0.000920396
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Epoch 166: f= 665.316, eps=0.001014737
Epoch 167: f= 665.313, eps=0.001065474
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Epoch 191: f= 665.062, eps=0.001636314
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Epoch 193: f= 665.037, eps=0.001804036
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Epoch 197: f= 664.982, eps=0.001044199
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Epoch 199: f= 664.970, eps=0.001151229
Epoch 200: f= 664.960, eps=0.001208791
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Epoch 214: f= 664.842, eps=0.001139678
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Epoch 217: f= 664.812, eps=0.001319319
Epoch 218: f= 664.828, eps=0.000659660
Epoch 219: f= 664.812, eps=0.000692643
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Epoch 222: f= 664.779, eps=0.000801820
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Epoch 225: f= 664.757, eps=0.000928207
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Epoch 227: f= 664.740, eps=0.001023349

Epoch 228: f= 664.730, eps=0.001074516
Epoch 229: f= 664.721, eps=0.001128242
Epoch 230: f= 664.713, eps=0.001184654
Epoch 231: f= 664.707, eps=0.001243887
Epoch 232: f= 664.706, eps=0.001306081
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Epoch 234: f= 664.690, eps=0.000685692
Epoch 235: f= 664.680, eps=0.000719977
Epoch 236: f= 664.675, eps=0.000755976
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Epoch 240: f= 664.636, eps=0.000918893
Epoch 241: f= 664.634, eps=0.000964838
Epoch 242: f= 664.624, eps=0.001013080
Epoch 243: f= 664.614, eps=0.001063734
Epoch 244: f= 664.608, eps=0.001116921
Epoch 245: f= 664.598, eps=0.001172767
Epoch 246: f= 664.592, eps=0.001231405
Epoch 247: f= 664.588, eps=0.001292975
Epoch 248: f= 664.581, eps=0.001357624
Epoch 249: f= 664.579, eps=0.001425505
Epoch 250: f= 664.566, eps=0.001496781
Epoch 251: f= 664.579, eps=0.000748390
Epoch 252: f= 664.553, eps=0.000785810
Epoch 253: f= 664.543, eps=0.000825100
Epoch 254: f= 664.524, eps=0.000866355
Epoch 255: f= 664.517, eps=0.000909673
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Epoch 257: f= 664.504, eps=0.001002915
Epoch 258: f= 664.495, eps=0.001053060
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Epoch 263: f= 664.467, eps=0.000640001
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Epoch 265: f= 664.453, eps=0.000705601
Epoch 266: f= 664.448, eps=0.000740881
Epoch 267: f= 664.441, eps=0.000777925
Epoch 268: f= 664.436, eps=0.000816821
Epoch 269: f= 664.430, eps=0.000857662
Epoch 270: f= 664.428, eps=0.000900545
Epoch 271: f= 664.417, eps=0.000945573
Epoch 272: f= 664.413, eps=0.000992851
Epoch 273: f= 664.404, eps=0.001042494
Epoch 274: f= 664.399, eps=0.001094618
Epoch 275: f= 664.393, eps=0.001149349

Epoch 276: f= 664.391, eps=0.001206817
Epoch 277: f= 664.388, eps=0.001267158
Epoch 278: f= 664.377, eps=0.001330516
Epoch 279: f= 664.378, eps=0.000665258
Epoch 280: f= 664.370, eps=0.000698521
Epoch 281: f= 664.359, eps=0.000733447
Epoch 282: f= 664.351, eps=0.000770119
Epoch 283: f= 664.349, eps=0.000808625
Epoch 284: f= 664.343, eps=0.000849056
Epoch 285: f= 664.332, eps=0.000891509
Epoch 286: f= 664.326, eps=0.000936084
Epoch 287: f= 664.318, eps=0.000982889
Epoch 288: f= 664.314, eps=0.001032033
Epoch 289: f= 664.310, eps=0.001083635
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Epoch 291: f= 664.292, eps=0.001194707
Epoch 292: f= 664.287, eps=0.001254443
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Epoch 294: f= 664.261, eps=0.001383023
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Epoch 296: f= 664.250, eps=0.000726087
Epoch 297: f= 664.244, eps=0.000762391
Epoch 298: f= 664.237, eps=0.000800511
Epoch 299: f= 664.233, eps=0.000840537
Epoch 300: f= 664.226, eps=0.000882563
Epoch 301: f= 664.219, eps=0.000926692
Epoch 302: f= 664.214, eps=0.000973026
Epoch 303: f= 664.211, eps=0.001021678
Epoch 304: f= 664.198, eps=0.001072761
Epoch 305: f= 664.193, eps=0.001126399
Epoch 306: f= 664.189, eps=0.001182719
Epoch 307: f= 664.187, eps=0.001241855
Epoch 308: f= 664.198, eps=0.000620928
Epoch 309: f= 664.177, eps=0.000651974
Epoch 310: f= 664.168, eps=0.000684573
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Epoch 312: f= 664.156, eps=0.000754742
Epoch 313: f= 664.147, eps=0.000792479
Epoch 314: f= 664.142, eps=0.000832103
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Epoch 316: f= 664.131, eps=0.000917393
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Epoch 318: f= 664.121, eps=0.001011426
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Epoch 320: f= 664.108, eps=0.001115097
Epoch 321: f= 664.116, eps=0.000557548
Epoch 322: f= 664.105, eps=0.000585426
Epoch 323: f= 664.096, eps=0.000614697

Epoch 324: f= 664.088, eps=0.000645432
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Epoch 328: f= 664.069, eps=0.000784527
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Epoch 330: f= 664.057, eps=0.000864941
Epoch 331: f= 664.050, eps=0.000908188
Epoch 332: f= 664.048, eps=0.000953597
Epoch 333: f= 664.044, eps=0.001001277
Epoch 334: f= 664.043, eps=0.001051341
Epoch 335: f= 664.028, eps=0.001103908
Epoch 336: f= 664.029, eps=0.000551954
Epoch 337: f= 664.022, eps=0.000579552
Epoch 338: f= 664.016, eps=0.000608529
Epoch 339: f= 664.014, eps=0.000638956
Epoch 340: f= 664.006, eps=0.000670903
Epoch 341: f= 664.003, eps=0.000704449
Epoch 342: f= 664.003, eps=0.000739671
Epoch 343: f= 664.000, eps=0.000776655
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Epoch 345: f= 663.984, eps=0.000856262
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Epoch 347: f= 663.980, eps=0.000449537
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Epoch 349: f= 663.971, eps=0.000495615
Epoch 350: f= 663.967, eps=0.000520396
Epoch 351: f= 663.963, eps=0.000546416
Epoch 352: f= 663.960, eps=0.000573736
Epoch 353: f= 663.953, eps=0.000602423
Epoch 354: f= 663.947, eps=0.000632544
Epoch 355: f= 663.943, eps=0.000664171
Epoch 356: f= 663.939, eps=0.000697380
Epoch 357: f= 663.934, eps=0.000732249
Epoch 358: f= 663.931, eps=0.000768861
Epoch 359: f= 663.928, eps=0.000807305
Epoch 360: f= 663.924, eps=0.000847670
Epoch 361: f= 663.918, eps=0.000890053
Epoch 362: f= 663.918, eps=0.000445027
Epoch 363: f= 663.913, eps=0.000467278
Epoch 364: f= 663.910, eps=0.000490642
Epoch 365: f= 663.907, eps=0.000515174
Epoch 366: f= 663.901, eps=0.000540933
Epoch 367: f= 663.897, eps=0.000567979
Epoch 368: f= 663.893, eps=0.000596378
Epoch 369: f= 663.890, eps=0.000626197
Epoch 370: f= 663.886, eps=0.000657507
Epoch 371: f= 663.882, eps=0.000690382

Epoch 372: f= 663.877, eps=0.000724902
Epoch 373: f= 663.877, eps=0.000761147
Epoch 374: f= 663.874, eps=0.000799204
Epoch 375: f= 663.869, eps=0.000839164
Epoch 376: f= 663.861, eps=0.000881122
Epoch 377: f= 663.855, eps=0.000925178
Epoch 378: f= 663.850, eps=0.000971437
Epoch 379: f= 663.843, eps=0.001020009
Epoch 380: f= 663.841, eps=0.001071010
Epoch 381: f= 663.841, eps=0.001124560
Epoch 382: f= 663.837, eps=0.001180788
Epoch 383: f= 663.832, eps=0.001239828
Epoch 384: f= 663.818, eps=0.001301819
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Epoch 388: f= 663.794, eps=0.000753509
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Epoch 425: f= 663.632, eps=0.001039092
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Epoch 428: f= 663.622, eps=0.000572799
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Epoch 430: f= 663.611, eps=0.000631511
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Epoch 434: f= 663.598, eps=0.000767606
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Epoch 447: f= 663.547, eps=0.000689255
Epoch 448: f= 663.542, eps=0.000723718
Epoch 449: f= 663.537, eps=0.000759904
Epoch 450: f= 663.532, eps=0.000797899
Epoch 451: f= 663.529, eps=0.000837794
Epoch 452: f= 663.525, eps=0.000879684
Epoch 453: f= 663.523, eps=0.000923668
Epoch 454: f= 663.517, eps=0.000969851
Epoch 455: f= 663.510, eps=0.001018344
Epoch 456: f= 663.514, eps=0.000509172
Epoch 457: f= 663.510, eps=0.000534630
Epoch 458: f= 663.505, eps=0.000561362
Epoch 459: f= 663.499, eps=0.000589430
Epoch 460: f= 663.496, eps=0.000618902
Epoch 461: f= 663.490, eps=0.000649847
Epoch 462: f= 663.489, eps=0.000682339
Epoch 463: f= 663.486, eps=0.000716456
Epoch 464: f= 663.479, eps=0.000752279
Epoch 465: f= 663.476, eps=0.000789893
Epoch 466: f= 663.468, eps=0.000829387
Epoch 467: f= 663.463, eps=0.000870857

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Epoch 468: f= 663.460, eps=0.000914399
Epoch 469: f= 663.456, eps=0.000960119
Epoch 470: f= 663.455, eps=0.001008125
Epoch 471: f= 663.446, eps=0.001058532
Epoch 472: f= 663.438, eps=0.001111458
Epoch 473: f= 663.432, eps=0.001167031
Epoch 474: f= 663.428, eps=0.001225383
Epoch 475: f= 663.418, eps=0.001286652
Epoch 476: f= 663.417, eps=0.001350984
Epoch 477: f= 663.423, eps=0.000675492
Epoch 478: f= 663.418, eps=0.000709267
Epoch 479: f= 663.409, eps=0.000744730
Epoch 480: f= 663.403, eps=0.000781967
Epoch 481: f= 663.396, eps=0.000821065
Epoch 482: f= 663.393, eps=0.000862118
Epoch 483: f= 663.388, eps=0.000905224
Epoch 484: f= 663.384, eps=0.000950485
Epoch 485: f= 663.377, eps=0.000998010
Epoch 486: f= 663.363, eps=0.001047910
Epoch 487: f= 663.362, eps=0.001100306
Epoch 488: f= 663.356, eps=0.001155321
Epoch 489: f= 663.358, eps=0.000577660
Epoch 490: f= 663.351, eps=0.000606543
Epoch 491: f= 663.343, eps=0.000636871
Epoch 492: f= 663.342, eps=0.000668714
Epoch 493: f= 663.339, eps=0.000702150
Epoch 494: f= 663.336, eps=0.000737257
Epoch 495: f= 663.333, eps=0.000774120
Epoch 496: f= 663.322, eps=0.000812826
Epoch 497: f= 663.317, eps=0.000853468
Epoch 498: f= 663.314, eps=0.000896141
Epoch 499: f= 663.311, eps=0.000940948
Result after 500 epochs: f=663.3023109198815

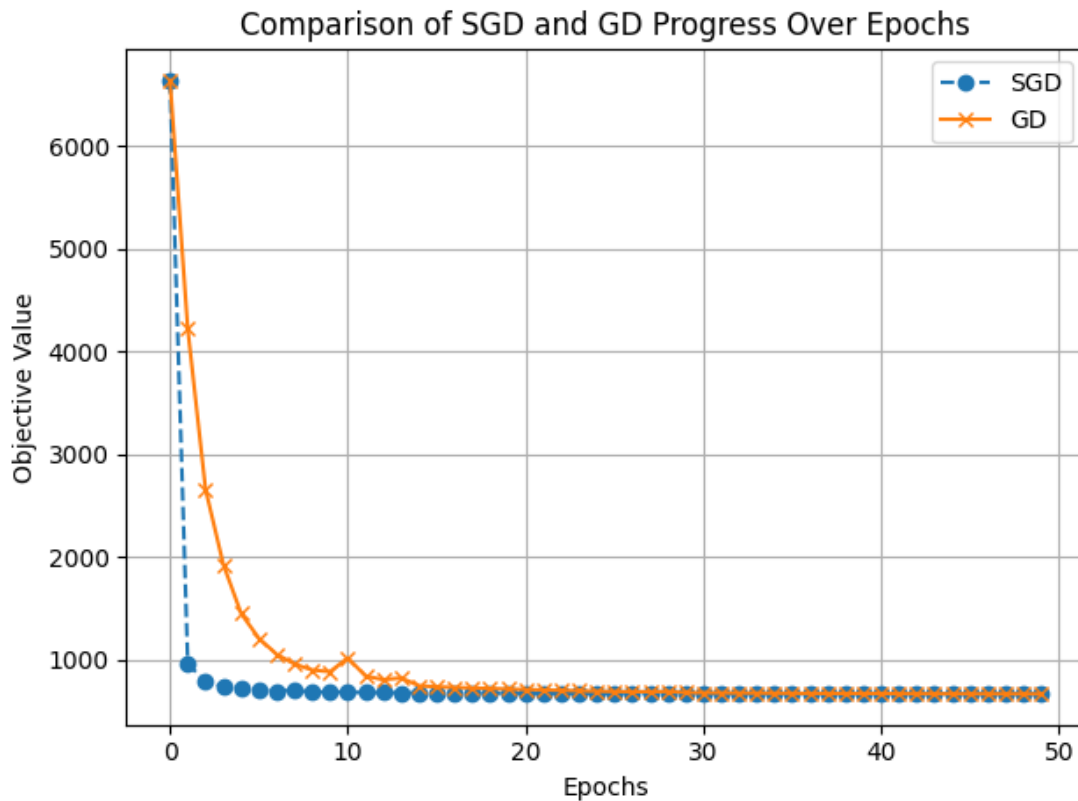
```

6.5 2e Compare GD and SGD

```

[304]: # YOUR CODE HERE
nextplot()
plt.plot(vz_sgd[0:50], label='SGD', linestyle='--', marker='o')
plt.plot(vz_gd[0:50], label='GD', linestyle='-', marker='x')
plt.xlabel('Epochs')
plt.ylabel('Objective Value')
plt.title('Comparison of SGD and GD Progress Over Epochs')
plt.legend()
plt.grid(True) # Optional: Adds a grid for better readability
plt.tight_layout()
plt.show()

```



7 3 Prediction

```
[305]: def predict(Xtest, w):
        """Compute predicted confidence values for logistic regression.

        Parameters
        -----
        Xtest : ndarray of shape (Ntest, D)
            Test data.
        w : ndarray of shape (D,)
            Weight vector for logistic regression.

        Returns
        -----
        ndarray of shape (Ntest,)
            Vector of predicted confidence values (probabilities).
        """
        return sigma(np.dot(Xtest, w))
```



```
def classify(Xtest, w):
    """Compute predicted class labels (0 or 1) for logistic regression.

    Parameters
    -----
    Xtest : ndarray of shape (Ntest, D)
        Test data.
    w : ndarray of shape (D,)
        Weight vector for logistic regression.

    Returns
    -----
    ndarray of shape (Ntest,)
        Vector of predicted class labels (0 or 1).
    """
    return np.where(predict(Xtest, w) >= 0.5, 1, 0)
```

```
[306]: # Example: confusion matrix
yhat = predict(Xtestz, wz_gd)
ypred = classify(Xtestz, wz_gd)
print(sklern.metrics.confusion_matrix(ytest, ypred)) # true x predicted
```

```
[[887  54]
 [ 71 524]]
```

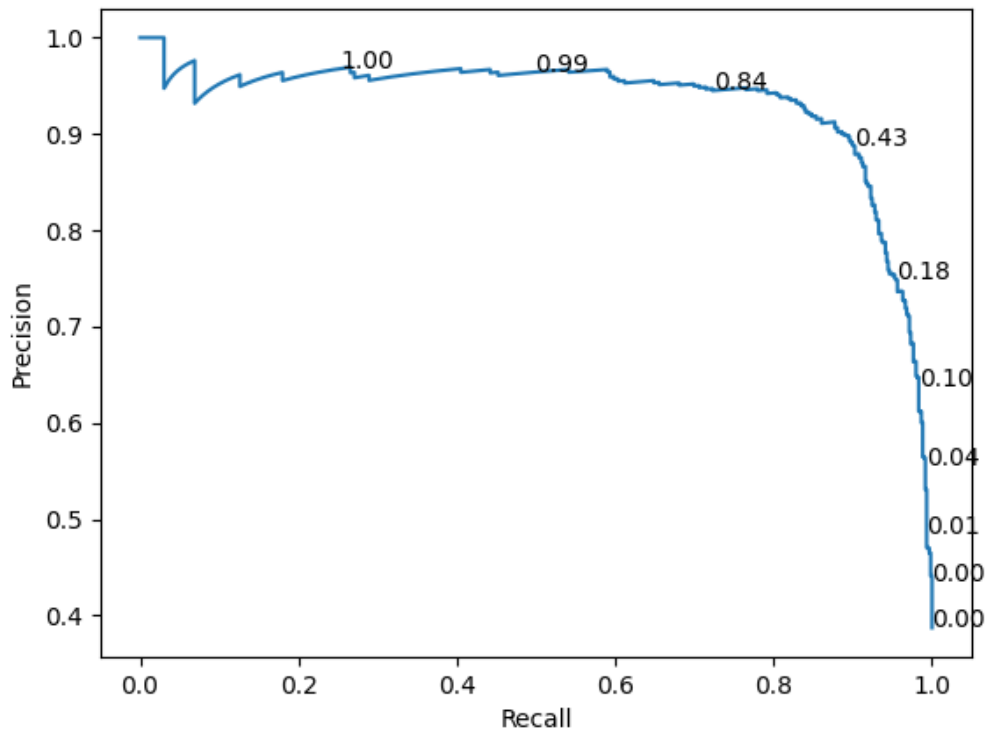
```
[307]: # Example: classification report
print(sklern.metrics.classification_report(ytest, ypred))
```

	precision	recall	f1-score	support
0	0.93	0.94	0.93	941
1	0.91	0.88	0.89	595
accuracy			0.92	1536
macro avg	0.92	0.91	0.91	1536
weighted avg	0.92	0.92	0.92	1536

```
[308]: # Example: precision-recall curve (with annotated thresholds)
nextplot()
precision, recall, thresholds = sklern.metrics.precision_recall_curve(ytest,
↪ yhat)
plt.plot(recall, precision)
for x in np.linspace(0, 1, 10, endpoint=False):
    index = int(x * (precision.size - 1))
    plt.text(recall[index], precision[index], "{:3.2f}".
↪ format(thresholds[index]))
```

```
plt.xlabel("Recall")
plt.ylabel("Precision")
```

```
[308]: Text(0, 0.5, 'Precision')
```



```
[309]: # Explore which features are considered important
# both the gradient descent (wz_gd) and stochastic gradient descent (wz_sgd)
↳ models
# YOUR CODE HERE
for feature, weight_gd, weight_sgd in zip(features, wz_gd, wz_sgd):
    print(f"{feature}: GD odds ratio = {np.exp(weight_gd):.3f}, SGD odds ratio = {np.exp(weight_sgd):.3f}")
↳ = {np.exp(weight_sgd):.3f}")
```

```
word_freq_make: GD odds ratio = 0.991, SGD odds ratio = 0.992
word_freq_address: GD odds ratio = 0.829, SGD odds ratio = 0.833
word_freq_all: GD odds ratio = 1.129, SGD odds ratio = 1.130
word_freq_3d: GD odds ratio = 3249.503, SGD odds ratio = 52.309
word_freq_our: GD odds ratio = 1.296, SGD odds ratio = 1.295
word_freq_over: GD odds ratio = 1.198, SGD odds ratio = 1.197
word_freq_remove: GD odds ratio = 3.169, SGD odds ratio = 3.292
word_freq_internet: GD odds ratio = 1.337, SGD odds ratio = 1.338
```

word_freq_order: GD odds ratio = 1.120, SGD odds ratio = 1.118
word_freq_mail: GD odds ratio = 1.068, SGD odds ratio = 1.064
word_freq_receive: GD odds ratio = 0.954, SGD odds ratio = 0.953
word_freq_will: GD odds ratio = 0.847, SGD odds ratio = 0.850
word_freq_people: GD odds ratio = 0.937, SGD odds ratio = 0.937
word_freq_report: GD odds ratio = 0.989, SGD odds ratio = 0.988
word_freq_addresses: GD odds ratio = 1.639, SGD odds ratio = 1.696
word_freq_free: GD odds ratio = 2.325, SGD odds ratio = 2.344
word_freq_business: GD odds ratio = 1.757, SGD odds ratio = 1.770
word_freq_email: GD odds ratio = 1.056, SGD odds ratio = 1.059
word_freq_you: GD odds ratio = 1.335, SGD odds ratio = 1.338
word_freq_credit: GD odds ratio = 1.330, SGD odds ratio = 1.358
word_freq_your: GD odds ratio = 1.243, SGD odds ratio = 1.236
word_freq_font: GD odds ratio = 1.944, SGD odds ratio = 2.001
word_freq_000: GD odds ratio = 4.313, SGD odds ratio = 4.997
word_freq_money: GD odds ratio = 1.290, SGD odds ratio = 1.304
word_freq_hp: GD odds ratio = 0.125, SGD odds ratio = 0.134
word_freq_hpl: GD odds ratio = 0.768, SGD odds ratio = 0.772
word_freq_george: GD odds ratio = 0.243, SGD odds ratio = 0.318
word_freq_650: GD odds ratio = 0.999, SGD odds ratio = 1.011
word_freq_lab: GD odds ratio = 0.736, SGD odds ratio = 0.758
word_freq_labs: GD odds ratio = 0.969, SGD odds ratio = 0.962
word_freq_telnet: GD odds ratio = 1.043, SGD odds ratio = 1.067
word_freq_857: GD odds ratio = 3.631, SGD odds ratio = 3.454
word_freq_data: GD odds ratio = 0.720, SGD odds ratio = 0.724
word_freq_415: GD odds ratio = 0.294, SGD odds ratio = 0.314
word_freq_85: GD odds ratio = 0.914, SGD odds ratio = 0.922
word_freq_technology: GD odds ratio = 1.497, SGD odds ratio = 1.494
word_freq_1999: GD odds ratio = 1.047, SGD odds ratio = 1.045
word_freq_parts: GD odds ratio = 0.859, SGD odds ratio = 0.858
word_freq_pm: GD odds ratio = 0.727, SGD odds ratio = 0.731
word_freq_direct: GD odds ratio = 0.806, SGD odds ratio = 0.811
word_freq_cs: GD odds ratio = 0.804, SGD odds ratio = 0.829
word_freq_meeting: GD odds ratio = 0.464, SGD odds ratio = 0.488
word_freq_original: GD odds ratio = 0.786, SGD odds ratio = 0.791
word_freq_project: GD odds ratio = 0.541, SGD odds ratio = 0.551
word_freq_re: GD odds ratio = 0.450, SGD odds ratio = 0.454
word_freq_edu: GD odds ratio = 0.350, SGD odds ratio = 0.369
word_freq_table: GD odds ratio = 0.861, SGD odds ratio = 0.855
word_freq_conference: GD odds ratio = 0.527, SGD odds ratio = 0.544
char_freq_;;: GD odds ratio = 0.603, SGD odds ratio = 0.597
char_freq_(: GD odds ratio = 0.818, SGD odds ratio = 0.813
char_freq_[: GD odds ratio = 0.897, SGD odds ratio = 0.894
char_freq_!: GD odds ratio = 1.268, SGD odds ratio = 1.274
char_freq_\$: GD odds ratio = 8.929, SGD odds ratio = 9.525
char_freq_#: GD odds ratio = 3.173, SGD odds ratio = 3.082
capital_run_length_average: GD odds ratio = 0.596, SGD odds ratio = 0.616
capital_run_length_longest: GD odds ratio = 10.111, SGD odds ratio = 9.049

capital_run_length_total: GD odds ratio = 1.240, SGD odds ratio = 1.255

```
[310]: # YOUR CODE HERE
gd_interpretable = {}
sgd_interpretable = {}
for i in np.argsort(wz_gd):
    gd_interpretable[features[i]] = np.exp(wz_gd[i])
    sgd_interpretable[features[i]] = np.exp(wz_sgd[i])

[311]: # Assuming gd_interpretable and sgd_interpretable are already populated
features = list(gd_interpretable.keys())

# Extracting values for plotting
gd_values = [gd_interpretable[feature] for feature in features]
sgd_values = [sgd_interpretable[feature] for feature in features]

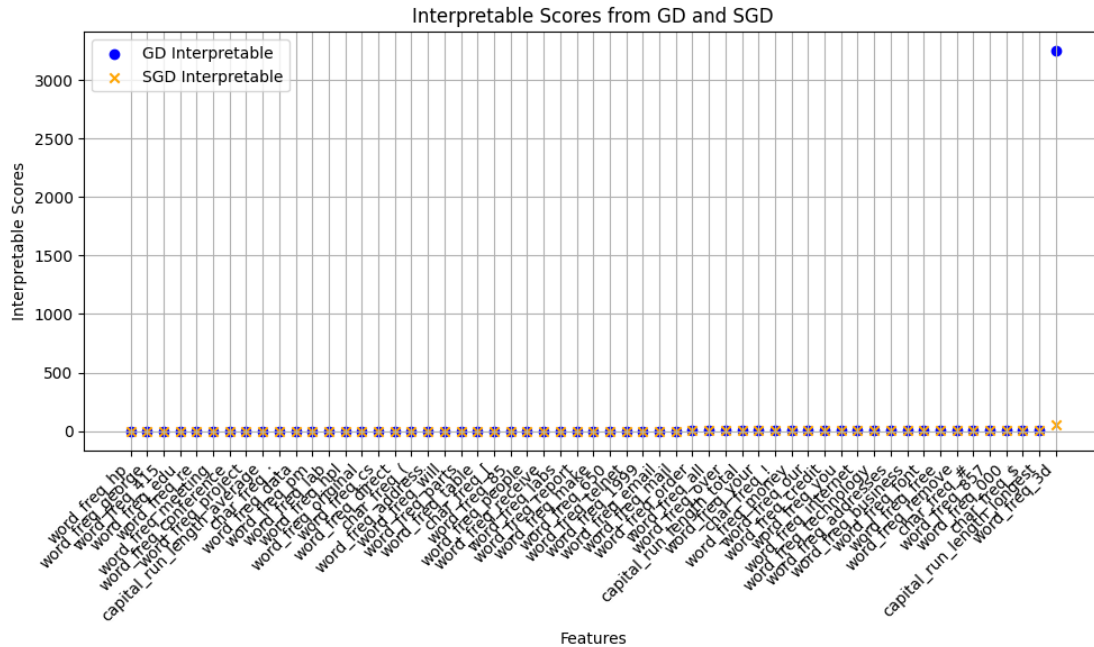
# Setting up the scatter plot
plt.figure(figsize=(10, 6))

# Scatter plot for GD values
plt.scatter(features, gd_values, color='blue', label='GD Interpretable',
            ↪marker='o')

# Scatter plot for SGD values
plt.scatter(features, sgd_values, color='orange', label='SGD Interpretable',
            ↪marker='x')

# Adding labels and title
plt.xlabel('Features')
plt.ylabel('Interpretable Scores')
plt.title('Interpretable Scores from GD and SGD')
plt.xticks(rotation=45, ha='right')
plt.legend()
plt.grid(True)

# Show the plot
plt.tight_layout()
plt.show()
```



8 4 Maximum A posteriori Estimation

8.1 4a Gradient Descent

```
[312]: def l_12(y, X, w, lambda_):
# YOUR CODE HERE

"""Log-density of posterior of logistic regression with weights w and L2
regularization parameter lambda_.

Parameters
-----
y : ndarray of shape (N,)
    Binary labels (either 0 or 1).
X : ndarray of shape (N, D)
    Design matrix.
w : ndarray of shape (D,)
    Weight vector.
lambda_ : float
    L2 regularization parameter.

Returns
-----
float
    Log-density of the posterior with L2 regularization.
"""
```

```
return l(y, X, w) - (lambda_ / 2) * (np.linalg.norm(w) ** 2)
```

```
[313]: # this should give:
# [-47066.641667825766, -47312.623810682911]
[l_12(y, Xz, np.linspace(-5, 5, D), 0), l_12(y, Xz, np.linspace(-5, 5, D), 1)]
```

```
[313]: [np.float64(-47066.64166782577), np.float64(-47312.62381068291)]
```

```
[314]: def dl_12(y, X, w, lambda_):
    # YOUR CODE HERE
    """Gradient of the log-density of the posterior of logistic regression with
    L2 regularization.

    Parameters
    -----
    y : ndarray of shape (N,)
        Binary labels (either 0 or 1).
    X : ndarray of shape (N, D)
        Design matrix.
    w : ndarray of shape (D,)
        Weight vector.
    lambda_ : float
        L2 regularization parameter.

    Returns
    -----
    ndarray of shape (D,)
        The gradient of the log-density of the posterior with L2 regularization.
    """
    # Compute the gradient with the L2 regularization term
    return dl(y, X, w) - lambda_ * w
```

```
[315]: # this should give:
# [array([ 551.33985842,  143.84116318,  841.83373606,  156.87237578,
#          802.61217579,  795.96202907,  920.69045803,  621.96516752,
#          659.18724769,  470.81259805,  771.32406968,  352.40325626,
#          455.66972482,  234.36600888,  562.45454038,  864.83981264,
#          787.19723703,  649.48042176,  902.6478154 ,  544.00539886,
#          1174.78638035,  120.3598967 ,  839.61141672,  633.30453444,
#          -706.66815087, -630.2039816 , -569.3451386 , -527.50996698,
#          -359.53701083, -476.64334832, -411.60620464, -375.11950586,
#          -345.37195689, -376.22044258, -407.31761977, -456.23251936,
#          -596.86960184, -107.97072355, -394.82170044, -229.18125598,
#          -288.46356547, -362.13402385, -450.87896465, -277.03932676,
#          -414.99293368, -452.28771693, -167.54649092, -270.9043748 ,
#          -252.20140951, -357.72497343, -259.12468742,  418.35938483,
#          604.54173228,  43.10390907,  152.24258478,  378.16731033,
```

```
#      416.12032881]),
# array([ 556.33985842,  148.66259175,  846.4765932 , 161.33666149,
#      806.89789007,  800.06917193,  924.61902946,  625.71516752,
#      662.75867626,  474.20545519,  774.5383554 ,  355.43897054,
#      458.52686767,  237.04458031,  564.95454038,  867.16124121,
#      789.34009417,  651.44470748,  904.43352968,  545.61254171,
#      1176.21495178,  121.6098967 ,  840.68284529,  634.19739158,
#      -705.95386516, -629.66826731, -568.98799574, -527.33139555,
#      -359.53701083, -476.82191975, -411.9633475 , -375.65522015,
#      -346.08624261, -377.11329972, -408.38904835, -457.48251936,
#      -598.29817327, -109.57786641, -396.60741472, -231.14554169,
#      -290.60642261, -364.45545242, -453.37896465, -279.71789819,
#      -417.85007654, -455.32343122, -170.76077664, -274.29723194,
#      -255.77283808, -361.47497343, -263.05325885,  414.25224198,
#      600.25601799,   38.63962335,  147.59972763,  373.34588176,
#      411.12032881)])
[dl_l2(y, Xz, np.linspace(-5, 5, D), 0), dl_l2(y, Xz, np.linspace(-5, 5, D), 1)]
```

```
[315]: [array([ 551.33985842,  143.84116318,  841.83373606, 156.87237578,
      802.61217579,  795.96202907,  920.69045803,  621.96516752,
      659.18724769,  470.81259805,  771.32406968,  352.40325626,
      455.66972482,  234.36600888,  562.45454038,  864.83981264,
      787.19723703,  649.48042176,  902.6478154 ,  544.00539886,
      1174.78638035,  120.3598967 ,  839.61141672,  633.30453444,
      -706.66815087, -630.2039816 , -569.3451386 , -527.50996698,
      -359.53701083, -476.64334832, -411.60620464, -375.11950586,
      -345.37195689, -376.22044258, -407.31761977, -456.23251936,
      -596.86960184, -107.97072355, -394.82170044, -229.18125598,
      -288.46356547, -362.13402385, -450.87896465, -277.03932676,
      -414.99293368, -452.28771693, -167.54649092, -270.9043748 ,
      -252.20140951, -357.72497343, -259.12468742,  418.35938483,
      604.54173228,   43.10390907,  152.24258478,  378.16731033,
      416.12032881]),
array([ 556.33985842,  148.66259175,  846.4765932 , 161.33666149,
      806.89789007,  800.06917193,  924.61902946,  625.71516752,
      662.75867626,  474.20545519,  774.5383554 ,  355.43897054,
      458.52686767,  237.04458031,  564.95454038,  867.16124121,
      789.34009417,  651.44470748,  904.43352968,  545.61254171,
      1176.21495178,  121.6098967 ,  840.68284529,  634.19739158,
      -705.95386516, -629.66826731, -568.98799574, -527.33139555,
      -359.53701083, -476.82191975, -411.9633475 , -375.65522015,
      -346.08624261, -377.11329972, -408.38904835, -457.48251936,
      -598.29817327, -109.57786641, -396.60741472, -231.14554169,
      -290.60642261, -364.45545242, -453.37896465, -279.71789819,
      -417.85007654, -455.32343122, -170.76077664, -274.29723194,
      -255.77283808, -361.47497343, -263.05325885,  414.25224198,
      600.25601799,   38.63962335,  147.59972763,  373.34588176,
```

```
411.12032881]]]
```

```
[316]: # now define the (f,update) tuple for optimize for logistic regression, L2
# regularization, and gradient descent
def gd_l2(y, X, lambda_):
    # YOUR CODE HERE
    def objective(w):
        """Objective function: Negative log-density of the posterior with L2
        ↪ regularization."""
        return -l_l2(y, X, w, lambda_)

    def update(w, eps):
        """Update function: Performs a gradient descent step with L2
        ↪ regularization."""
        return w + eps * dl_l2(y, X, w, lambda_)
    return (objective, update)
```

```
[317]: # let's run!
lambda_ = 100
wz_gd_l2, vz_gd_l2, ez_gd_l2 = optimize(gd_l2(y, Xz, lambda_), w0, nepochs=500)
```

```
Epoch 0: f= 9992.358, eps=0.010000000
Epoch 1: f= 23977.384, eps=0.005000000
Epoch 2: f= 5534.851, eps=0.005250000
Epoch 3: f= 1427.453, eps=0.005512500
Epoch 4: f= 1131.716, eps=0.005788125
Epoch 5: f= 1540.933, eps=0.002894063
Epoch 6: f= 1323.168, eps=0.003038766
Epoch 7: f= 1049.068, eps=0.003190704
Epoch 8: f= 1067.960, eps=0.001595352
Epoch 9: f= 989.861, eps=0.001675120
Epoch 10: f= 988.742, eps=0.001758876
Epoch 11: f= 988.585, eps=0.001846819
Epoch 12: f= 988.539, eps=0.001939160
Epoch 13: f= 988.522, eps=0.002036118
Epoch 14: f= 988.516, eps=0.002137924
Epoch 15: f= 988.513, eps=0.002244820
Epoch 16: f= 988.512, eps=0.002357061
Epoch 17: f= 988.512, eps=0.002474914
Epoch 18: f= 988.512, eps=0.002598660
Epoch 19: f= 988.512, eps=0.002728593
Epoch 20: f= 988.512, eps=0.002865023
Epoch 21: f= 988.512, eps=0.003008274
Epoch 22: f= 988.512, eps=0.003158688
Epoch 23: f= 988.512, eps=0.003316622
Epoch 24: f= 988.512, eps=0.001658311
Epoch 25: f= 988.512, eps=0.001741227
```


Epoch	26:	f=	988.512,	eps=0.001828288
Epoch	27:	f=	988.512,	eps=0.001919702
Epoch	28:	f=	988.512,	eps=0.002015687
Epoch	29:	f=	988.512,	eps=0.002116472
Epoch	30:	f=	988.512,	eps=0.002222295
Epoch	31:	f=	988.512,	eps=0.002333410
Epoch	32:	f=	988.512,	eps=0.002450081
Epoch	33:	f=	988.512,	eps=0.002572585
Epoch	34:	f=	988.512,	eps=0.002701214
Epoch	35:	f=	988.512,	eps=0.002836275
Epoch	36:	f=	988.512,	eps=0.002978088
Epoch	37:	f=	988.512,	eps=0.003126993
Epoch	38:	f=	988.512,	eps=0.003283342
Epoch	39:	f=	988.512,	eps=0.003447510
Epoch	40:	f=	988.512,	eps=0.003619885
Epoch	41:	f=	988.512,	eps=0.001809943
Epoch	42:	f=	988.512,	eps=0.001900440
Epoch	43:	f=	988.512,	eps=0.001995462
Epoch	44:	f=	988.512,	eps=0.002095235
Epoch	45:	f=	988.512,	eps=0.002199996
Epoch	46:	f=	988.512,	eps=0.002309996
Epoch	47:	f=	988.512,	eps=0.002425496
Epoch	48:	f=	988.512,	eps=0.002546771
Epoch	49:	f=	988.512,	eps=0.001273385
Epoch	50:	f=	988.512,	eps=0.001337055
Epoch	51:	f=	988.512,	eps=0.001403907
Epoch	52:	f=	988.512,	eps=0.001474103
Epoch	53:	f=	988.512,	eps=0.001547808
Epoch	54:	f=	988.512,	eps=0.000773904
Epoch	55:	f=	988.512,	eps=0.000812599
Epoch	56:	f=	988.512,	eps=0.000853229
Epoch	57:	f=	988.512,	eps=0.000426615
Epoch	58:	f=	988.512,	eps=0.000447945
Epoch	59:	f=	988.512,	eps=0.000470343
Epoch	60:	f=	988.512,	eps=0.000493860
Epoch	61:	f=	988.512,	eps=0.000246930
Epoch	62:	f=	988.512,	eps=0.000259276
Epoch	63:	f=	988.512,	eps=0.000272240
Epoch	64:	f=	988.512,	eps=0.000285852
Epoch	65:	f=	988.512,	eps=0.000142926
Epoch	66:	f=	988.512,	eps=0.000150072
Epoch	67:	f=	988.512,	eps=0.000157576
Epoch	68:	f=	988.512,	eps=0.000078788
Epoch	69:	f=	988.512,	eps=0.000082727
Epoch	70:	f=	988.512,	eps=0.000086864
Epoch	71:	f=	988.512,	eps=0.000043432
Epoch	72:	f=	988.512,	eps=0.000045603
Epoch	73:	f=	988.512,	eps=0.000047884

Epoch 74: f= 988.512, eps=0.000023942
Epoch 75: f= 988.512, eps=0.000025139
Epoch 76: f= 988.512, eps=0.000026396
Epoch 77: f= 988.512, eps=0.000013198
Epoch 78: f= 988.512, eps=0.000013858
Epoch 79: f= 988.512, eps=0.000006929
Epoch 80: f= 988.512, eps=0.000007275
Epoch 81: f= 988.512, eps=0.000007639
Epoch 82: f= 988.512, eps=0.000008021
Epoch 83: f= 988.512, eps=0.000004011
Epoch 84: f= 988.512, eps=0.000004211
Epoch 85: f= 988.512, eps=0.000004422
Epoch 86: f= 988.512, eps=0.000002211
Epoch 87: f= 988.512, eps=0.000002321
Epoch 88: f= 988.512, eps=0.000001161
Epoch 89: f= 988.512, eps=0.000001219
Epoch 90: f= 988.512, eps=0.000000609
Epoch 91: f= 988.512, eps=0.000000640
Epoch 92: f= 988.512, eps=0.000000672
Epoch 93: f= 988.512, eps=0.000000336
Epoch 94: f= 988.512, eps=0.000000353
Epoch 95: f= 988.512, eps=0.000000176
Epoch 96: f= 988.512, eps=0.000000185
Epoch 97: f= 988.512, eps=0.000000093
Epoch 98: f= 988.512, eps=0.000000097
Epoch 99: f= 988.512, eps=0.000000102
Epoch 100: f= 988.512, eps=0.000000107
Epoch 101: f= 988.512, eps=0.000000113
Epoch 102: f= 988.512, eps=0.000000056
Epoch 103: f= 988.512, eps=0.000000059
Epoch 104: f= 988.512, eps=0.000000062
Epoch 105: f= 988.512, eps=0.000000065
Epoch 106: f= 988.512, eps=0.000000068
Epoch 107: f= 988.512, eps=0.000000072
Epoch 108: f= 988.512, eps=0.000000075
Epoch 109: f= 988.512, eps=0.000000079
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Result after 500 epochs: f=988.511839602703

8.2 4b Effect of Prior

```
[318]: # YOUR CODE HERE
# Define a range of lambda values to explore the effect of L2 regularization
# strength
lam_values = [0, 0.01, 0.1, 0.5, 1, 2, 3, 4, 5, 10, 20, 100, 200, 500]
results = {} # Initialize a dictionary to store results for each lambda

# Loop over each lambda value, performing gradient descent with L2
# regularization
for lam in lam_values:
    np.random.seed(0) # Set a seed for reproducibility in weight initialization
    w0 = np.random.normal(size=D) # Initialize weights randomly

    # Optimize logistic regression with L2 regularization for the current lambda
    wz, vz, ez = optimize(gd_l2(y, Xz, lam), w0, nepochs=500)

    # Store final weights and objective value after training
    results[str(lam)] = {
        'final_weights': wz, # Final weight vector after optimization
        'final_nll_values': vz,
        'final_objective': ez[-1] # Final value of the objective function
    }

# Print out the final objective values for each lambda to compare
# regularization effects
for lam, res in results.items():
    print(f"Lambda = {lam}: Final Objective = {res['final_objective']:.4f}")
```

```
Epoch 0: f= 6636.208, eps=0.010000000
Epoch 1: f= 4216.957, eps=0.010500000
Epoch 2: f= 2657.519, eps=0.011025000
Epoch 3: f= 1926.135, eps=0.011576250
Epoch 4: f= 1449.495, eps=0.012155063
Epoch 5: f= 1207.529, eps=0.012762816
Epoch 6: f= 1052.489, eps=0.013400956
Epoch 7: f= 957.275, eps=0.014071004
Epoch 8: f= 899.610, eps=0.014774554
Epoch 9: f= 882.904, eps=0.015513282
Epoch 10: f= 1017.083, eps=0.007756641
Epoch 11: f= 840.760, eps=0.008144473
Epoch 12: f= 805.649, eps=0.008551697
Epoch 13: f= 822.108, eps=0.004275848
Epoch 14: f= 746.377, eps=0.004489641
Epoch 15: f= 735.803, eps=0.004714123
Epoch 16: f= 729.780, eps=0.004949829
Epoch 17: f= 724.467, eps=0.005197320
Epoch 18: f= 719.408, eps=0.005457186
```

Epoch 19: f= 714.564, eps=0.005730046
Epoch 20: f= 709.932, eps=0.006016548
Epoch 21: f= 705.514, eps=0.006317375
Epoch 22: f= 701.321, eps=0.006633244
Epoch 23: f= 697.373, eps=0.006964906
Epoch 24: f= 693.728, eps=0.007313152
Epoch 25: f= 690.591, eps=0.007678809
Epoch 26: f= 688.614, eps=0.008062750
Epoch 27: f= 688.607, eps=0.008465887
Epoch 28: f= 690.854, eps=0.004232944
Epoch 29: f= 679.967, eps=0.004444591
Epoch 30: f= 678.649, eps=0.004666820
Epoch 31: f= 677.447, eps=0.004900161
Epoch 32: f= 676.292, eps=0.005145169
Epoch 33: f= 675.182, eps=0.005402428
Epoch 34: f= 674.120, eps=0.005672549
Epoch 35: f= 673.114, eps=0.005956177
Epoch 36: f= 672.177, eps=0.006253986
Epoch 37: f= 671.334, eps=0.006566685
Epoch 38: f= 670.656, eps=0.006895019
Epoch 39: f= 670.397, eps=0.007239770
Epoch 40: f= 671.342, eps=0.003619885
Epoch 41: f= 668.932, eps=0.003800879
Epoch 42: f= 668.378, eps=0.003990923
Epoch 43: f= 668.027, eps=0.004190469
Epoch 44: f= 667.720, eps=0.004399993
Epoch 45: f= 667.433, eps=0.004619993
Epoch 46: f= 667.159, eps=0.004850992
Epoch 47: f= 666.897, eps=0.005093542
Epoch 48: f= 666.650, eps=0.005348219
Epoch 49: f= 666.417, eps=0.005615630
Epoch 50: f= 666.201, eps=0.005896411
Epoch 51: f= 666.008, eps=0.006191232
Epoch 52: f= 665.858, eps=0.006500794
Epoch 53: f= 665.812, eps=0.006825833
Epoch 54: f= 666.068, eps=0.003412917
Epoch 55: f= 665.424, eps=0.003583562
Epoch 56: f= 665.290, eps=0.003762741
Epoch 57: f= 665.204, eps=0.003950878
Epoch 58: f= 665.128, eps=0.004148421
Epoch 59: f= 665.054, eps=0.004355843
Epoch 60: f= 664.982, eps=0.004573635
Epoch 61: f= 664.911, eps=0.004802316
Epoch 62: f= 664.842, eps=0.005042432
Epoch 63: f= 664.773, eps=0.005294554
Epoch 64: f= 664.707, eps=0.005559282
Epoch 65: f= 664.641, eps=0.005837246
Epoch 66: f= 664.578, eps=0.006129108

Epoch 67: f= 664.518, eps=0.006435563
 Epoch 68: f= 664.467, eps=0.006757341
 Epoch 69: f= 664.446, eps=0.007095208
 Epoch 70: f= 664.544, eps=0.003547604
 Epoch 71: f= 664.339, eps=0.003724984
 Epoch 72: f= 664.278, eps=0.003911234
 Epoch 73: f= 664.239, eps=0.004106795
 Epoch 74: f= 664.206, eps=0.004312135
 Epoch 75: f= 664.173, eps=0.004527742
 Epoch 76: f= 664.139, eps=0.004754129
 Epoch 77: f= 664.106, eps=0.004991835
 Epoch 78: f= 664.072, eps=0.005241427
 Epoch 79: f= 664.037, eps=0.005503499
 Epoch 80: f= 664.002, eps=0.005778674
 Epoch 81: f= 663.967, eps=0.006067607
 Epoch 82: f= 663.936, eps=0.006370988
 Epoch 83: f= 663.918, eps=0.006689537
 Epoch 84: f= 663.948, eps=0.003344768
 Epoch 85: f= 663.839, eps=0.003512007
 Epoch 86: f= 663.807, eps=0.003687607
 Epoch 87: f= 663.783, eps=0.003871988
 Epoch 88: f= 663.760, eps=0.004065587
 Epoch 89: f= 663.737, eps=0.004268866
 Epoch 90: f= 663.713, eps=0.004482310
 Epoch 91: f= 663.688, eps=0.004706425
 Epoch 92: f= 663.661, eps=0.004941746
 Epoch 93: f= 663.634, eps=0.005188834
 Epoch 94: f= 663.606, eps=0.005448275
 Epoch 95: f= 663.576, eps=0.005720689
 Epoch 96: f= 663.546, eps=0.006006724
 Epoch 97: f= 663.514, eps=0.006307060
 Epoch 98: f= 663.482, eps=0.006622413
 Epoch 99: f= 663.451, eps=0.006953533
 Epoch 100: f= 663.427, eps=0.007301210
 Epoch 101: f= 663.442, eps=0.003650605
 Epoch 102: f= 663.371, eps=0.003833135
 Epoch 103: f= 663.340, eps=0.004024792
 Epoch 104: f= 663.316, eps=0.004226032
 Epoch 105: f= 663.294, eps=0.004437333
 Epoch 106: f= 663.271, eps=0.004659200
 Epoch 107: f= 663.248, eps=0.004892160
 Epoch 108: f= 663.223, eps=0.005136768
 Epoch 109: f= 663.198, eps=0.005393606
 Epoch 110: f= 663.172, eps=0.005663287
 Epoch 111: f= 663.146, eps=0.005946451
 Epoch 112: f= 663.121, eps=0.006243773
 Epoch 113: f= 663.102, eps=0.006555962
 Epoch 114: f= 663.108, eps=0.003277981

Epoch 115: f= 663.042, eps=0.003441880
Epoch 116: f= 663.019, eps=0.003613974
Epoch 117: f= 663.001, eps=0.003794673
Epoch 118: f= 662.982, eps=0.003984406
Epoch 119: f= 662.963, eps=0.004183627
Epoch 120: f= 662.943, eps=0.004392808
Epoch 121: f= 662.922, eps=0.004612449
Epoch 122: f= 662.900, eps=0.004843071
Epoch 123: f= 662.877, eps=0.005085225
Epoch 124: f= 662.853, eps=0.005339486
Epoch 125: f= 662.828, eps=0.005606460
Epoch 126: f= 662.802, eps=0.005886783
Epoch 127: f= 662.774, eps=0.006181122
Epoch 128: f= 662.745, eps=0.006490178
Epoch 129: f= 662.715, eps=0.006814687
Epoch 130: f= 662.685, eps=0.007155422
Epoch 131: f= 662.659, eps=0.007513193
Epoch 132: f= 662.656, eps=0.007888852
Epoch 133: f= 662.786, eps=0.003944426
Epoch 134: f= 662.631, eps=0.004141647
Epoch 135: f= 662.578, eps=0.004348730
Epoch 136: f= 662.545, eps=0.004566166
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Epoch 138: f= 662.497, eps=0.005034198
Epoch 139: f= 662.477, eps=0.005285908
Epoch 140: f= 662.462, eps=0.005550204
Epoch 141: f= 662.457, eps=0.005827714
Epoch 142: f= 662.476, eps=0.002913857
Epoch 143: f= 662.373, eps=0.003059550
Epoch 144: f= 662.355, eps=0.003212527
Epoch 145: f= 662.340, eps=0.003373154
Epoch 146: f= 662.325, eps=0.003541811
Epoch 147: f= 662.310, eps=0.003718902
Epoch 148: f= 662.293, eps=0.003904847
Epoch 149: f= 662.276, eps=0.004100089
Epoch 150: f= 662.257, eps=0.004305094
Epoch 151: f= 662.238, eps=0.004520348
Epoch 152: f= 662.218, eps=0.004746366
Epoch 153: f= 662.197, eps=0.004983684
Epoch 154: f= 662.175, eps=0.005232868
Epoch 155: f= 662.152, eps=0.005494512
Epoch 156: f= 662.128, eps=0.005769237
Epoch 157: f= 662.103, eps=0.006057699
Epoch 158: f= 662.076, eps=0.006360584
Epoch 159: f= 662.048, eps=0.006678613
Epoch 160: f= 662.019, eps=0.007012544
Epoch 161: f= 661.989, eps=0.007363171
Epoch 162: f= 661.957, eps=0.007731330

Epoch 163: f= 661.924, eps=0.008117896
Epoch 164: f= 661.890, eps=0.008523791
Epoch 165: f= 661.859, eps=0.008949981
Epoch 166: f= 661.868, eps=0.004474990
Epoch 167: f= 661.834, eps=0.004698740
Epoch 168: f= 661.809, eps=0.004933677
Epoch 169: f= 661.791, eps=0.005180361
Epoch 170: f= 661.780, eps=0.005439379
Epoch 171: f= 661.784, eps=0.002719689
Epoch 172: f= 661.698, eps=0.002855674
Epoch 173: f= 661.685, eps=0.002998458
Epoch 174: f= 661.672, eps=0.003148380
Epoch 175: f= 661.659, eps=0.003305799
Epoch 176: f= 661.645, eps=0.003471089
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Epoch 183: f= 661.526, eps=0.004884171
Epoch 184: f= 661.506, eps=0.005128380
Epoch 185: f= 661.485, eps=0.005384799
Epoch 186: f= 661.462, eps=0.005654039
Epoch 187: f= 661.439, eps=0.005936741
Epoch 188: f= 661.414, eps=0.006233578
Epoch 189: f= 661.388, eps=0.006545257
Epoch 190: f= 661.361, eps=0.006872520
Epoch 191: f= 661.333, eps=0.007216146
Epoch 192: f= 661.303, eps=0.007576953
Epoch 193: f= 661.272, eps=0.007955801
Epoch 194: f= 661.240, eps=0.008353591
Epoch 195: f= 661.206, eps=0.008771270
Epoch 196: f= 661.170, eps=0.009209834
Epoch 197: f= 661.133, eps=0.009670325
Epoch 198: f= 661.097, eps=0.010153842
Epoch 199: f= 661.093, eps=0.010661534
Epoch 200: f= 661.463, eps=0.005330767
Epoch 201: f= 661.555, eps=0.002665383
Epoch 202: f= 660.978, eps=0.002798653
Epoch 203: f= 660.966, eps=0.002938585
Epoch 204: f= 660.955, eps=0.003085514
Epoch 205: f= 660.942, eps=0.003239790
Epoch 206: f= 660.929, eps=0.003401780
Epoch 207: f= 660.916, eps=0.003571869
Epoch 208: f= 660.902, eps=0.003750462
Epoch 209: f= 660.887, eps=0.003937985
Epoch 210: f= 660.871, eps=0.004134885

Epoch 211: f= 660.855, eps=0.004341629
Epoch 212: f= 660.837, eps=0.004558710
Epoch 213: f= 660.819, eps=0.004786646
Epoch 214: f= 660.801, eps=0.005025978
Epoch 215: f= 660.781, eps=0.005277277
Epoch 216: f= 660.760, eps=0.005541141
Epoch 217: f= 660.738, eps=0.005818198
Epoch 218: f= 660.715, eps=0.006109108
Epoch 219: f= 660.691, eps=0.006414563
Epoch 220: f= 660.666, eps=0.006735291
Epoch 221: f= 660.640, eps=0.007072056
Epoch 222: f= 660.612, eps=0.007425659
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Epoch 224: f= 660.553, eps=0.008186788
Epoch 225: f= 660.521, eps=0.008596128
Epoch 226: f= 660.488, eps=0.009025934
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Epoch 228: f= 660.417, eps=0.009951093
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Epoch 230: f= 660.344, eps=0.010971080
Epoch 231: f= 660.362, eps=0.005485540
Epoch 232: f= 660.377, eps=0.002742770
Epoch 233: f= 660.267, eps=0.002879908
Epoch 234: f= 660.254, eps=0.003023904
Epoch 235: f= 660.243, eps=0.003175099
Epoch 236: f= 660.231, eps=0.003333854
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Epoch 238: f= 660.205, eps=0.003675574
Epoch 239: f= 660.191, eps=0.003859353
Epoch 240: f= 660.176, eps=0.004052320
Epoch 241: f= 660.161, eps=0.004254936
Epoch 242: f= 660.145, eps=0.004467683
Epoch 243: f= 660.128, eps=0.004691067
Epoch 244: f= 660.111, eps=0.004925621
Epoch 245: f= 660.092, eps=0.005171902
Epoch 246: f= 660.073, eps=0.005430497
Epoch 247: f= 660.052, eps=0.005702022
Epoch 248: f= 660.031, eps=0.005987123
Epoch 249: f= 660.009, eps=0.006286479
Epoch 250: f= 659.985, eps=0.006600803
Epoch 251: f= 659.961, eps=0.006930843
Epoch 252: f= 659.935, eps=0.007277385
Epoch 253: f= 659.908, eps=0.007641254
Epoch 254: f= 659.880, eps=0.008023317
Epoch 255: f= 659.850, eps=0.008424483
Epoch 256: f= 659.819, eps=0.008845707
Epoch 257: f= 659.787, eps=0.009287992
Epoch 258: f= 659.754, eps=0.009752392

Epoch 259: f= 659.737, eps=0.010240012
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Epoch 261: f= 659.906, eps=0.002560003
Epoch 262: f= 659.651, eps=0.002688003
Epoch 263: f= 659.641, eps=0.002822403
Epoch 264: f= 659.631, eps=0.002963523
Epoch 265: f= 659.620, eps=0.003111700
Epoch 266: f= 659.609, eps=0.003267285
Epoch 267: f= 659.597, eps=0.003430649
Epoch 268: f= 659.585, eps=0.003602181
Epoch 269: f= 659.572, eps=0.003782290
Epoch 270: f= 659.558, eps=0.003971405
Epoch 271: f= 659.543, eps=0.004169975
Epoch 272: f= 659.528, eps=0.004378474
Epoch 273: f= 659.513, eps=0.004597397
Epoch 274: f= 659.496, eps=0.004827267
Epoch 275: f= 659.479, eps=0.005068631
Epoch 276: f= 659.460, eps=0.005322062
Epoch 277: f= 659.441, eps=0.005588165
Epoch 278: f= 659.421, eps=0.005867574
Epoch 279: f= 659.400, eps=0.006160952
Epoch 280: f= 659.378, eps=0.006469000
Epoch 281: f= 659.355, eps=0.006792450
Epoch 282: f= 659.331, eps=0.007132072
Epoch 283: f= 659.305, eps=0.007488676
Epoch 284: f= 659.279, eps=0.007863110
Epoch 285: f= 659.251, eps=0.008256265
Epoch 286: f= 659.222, eps=0.008669078
Epoch 287: f= 659.191, eps=0.009102532
Epoch 288: f= 659.159, eps=0.009557659
Epoch 289: f= 659.125, eps=0.010035542
Epoch 290: f= 659.090, eps=0.010537319
Epoch 291: f= 659.053, eps=0.011064185
Epoch 292: f= 659.016, eps=0.011617394
Epoch 293: f= 658.992, eps=0.012198264
Epoch 294: f= 659.226, eps=0.006099132
Epoch 295: f= 659.526, eps=0.003049566
Epoch 296: f= 658.916, eps=0.003202044
Epoch 297: f= 658.891, eps=0.003362147
Epoch 298: f= 658.878, eps=0.003530254
Epoch 299: f= 658.865, eps=0.003706767
Epoch 300: f= 658.852, eps=0.003892105
Epoch 301: f= 658.839, eps=0.004086710
Epoch 302: f= 658.825, eps=0.004291046
Epoch 303: f= 658.810, eps=0.004505598
Epoch 304: f= 658.795, eps=0.004730878
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Epoch 306: f= 658.761, eps=0.005215793

Epoch 307: f= 658.743, eps=0.005476582
Epoch 308: f= 658.725, eps=0.005750412
Epoch 309: f= 658.705, eps=0.006037932
Epoch 310: f= 658.684, eps=0.006339829
Epoch 311: f= 658.663, eps=0.006656820
Epoch 312: f= 658.640, eps=0.006989661
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Epoch 314: f= 658.593, eps=0.007706101
Epoch 315: f= 658.573, eps=0.008091406
Epoch 316: f= 658.582, eps=0.004045703
Epoch 317: f= 658.544, eps=0.004247988
Epoch 318: f= 658.521, eps=0.004460388
Epoch 319: f= 658.503, eps=0.004683407
Epoch 320: f= 658.486, eps=0.004917578
Epoch 321: f= 658.470, eps=0.005163456
Epoch 322: f= 658.455, eps=0.005421629
Epoch 323: f= 658.443, eps=0.005692711
Epoch 324: f= 658.436, eps=0.005977346
Epoch 325: f= 658.450, eps=0.002988673
Epoch 326: f= 658.381, eps=0.003138107
Epoch 327: f= 658.368, eps=0.003295012
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Epoch 329: f= 658.345, eps=0.003632751
Epoch 330: f= 658.333, eps=0.003814388
Epoch 331: f= 658.320, eps=0.004005108
Epoch 332: f= 658.307, eps=0.004205363
Epoch 333: f= 658.293, eps=0.004415631
Epoch 334: f= 658.278, eps=0.004636413
Epoch 335: f= 658.263, eps=0.004868234
Epoch 336: f= 658.247, eps=0.005111645
Epoch 337: f= 658.230, eps=0.005367228
Epoch 338: f= 658.212, eps=0.005635589
Epoch 339: f= 658.193, eps=0.005917368
Epoch 340: f= 658.174, eps=0.006213237
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Epoch 342: f= 658.132, eps=0.006850094
Epoch 343: f= 658.109, eps=0.007192598
Epoch 344: f= 658.086, eps=0.007552228
Epoch 345: f= 658.061, eps=0.007929840
Epoch 346: f= 658.036, eps=0.008326332
Epoch 347: f= 658.017, eps=0.008742648
Epoch 348: f= 658.040, eps=0.004371324
Epoch 349: f= 658.004, eps=0.004589890
Epoch 350: f= 657.981, eps=0.004819385
Epoch 351: f= 657.965, eps=0.005060354
Epoch 352: f= 657.954, eps=0.005313372
Epoch 353: f= 657.953, eps=0.005579040
Epoch 354: f= 657.969, eps=0.002789520

Epoch 355: f= 657.876, eps=0.002928996
Epoch 356: f= 657.864, eps=0.003075446
Epoch 357: f= 657.854, eps=0.003229218
Epoch 358: f= 657.844, eps=0.003390679
Epoch 359: f= 657.833, eps=0.003560213
Epoch 360: f= 657.821, eps=0.003738224
Epoch 361: f= 657.809, eps=0.003925135
Epoch 362: f= 657.797, eps=0.004121392
Epoch 363: f= 657.783, eps=0.004327461
Epoch 364: f= 657.770, eps=0.004543834
Epoch 365: f= 657.755, eps=0.004771026
Epoch 366: f= 657.740, eps=0.005009577
Epoch 367: f= 657.724, eps=0.005260056
Epoch 368: f= 657.707, eps=0.005523059
Epoch 369: f= 657.689, eps=0.005799212
Epoch 370: f= 657.671, eps=0.006089173
Epoch 371: f= 657.651, eps=0.006393631
Epoch 372: f= 657.631, eps=0.006713313
Epoch 373: f= 657.609, eps=0.007048978
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Epoch 375: f= 657.564, eps=0.007771499
Epoch 376: f= 657.539, eps=0.008160074
Epoch 377: f= 657.513, eps=0.008568077
Epoch 378: f= 657.486, eps=0.008996481
Epoch 379: f= 657.460, eps=0.009446305
Epoch 380: f= 657.445, eps=0.009918621
Epoch 381: f= 657.554, eps=0.004959310
Epoch 382: f= 657.540, eps=0.005207276
Epoch 383: f= 657.567, eps=0.002603638
Epoch 384: f= 657.357, eps=0.002733820
Epoch 385: f= 657.348, eps=0.002870511
Epoch 386: f= 657.339, eps=0.003014036
Epoch 387: f= 657.330, eps=0.003164738
Epoch 388: f= 657.320, eps=0.003322975
Epoch 389: f= 657.310, eps=0.003489124
Epoch 390: f= 657.299, eps=0.003663580
Epoch 391: f= 657.287, eps=0.003846759
Epoch 392: f= 657.275, eps=0.004039097
Epoch 393: f= 657.263, eps=0.004241052
Epoch 394: f= 657.250, eps=0.004453104
Epoch 395: f= 657.236, eps=0.004675760
Epoch 396: f= 657.221, eps=0.004909548
Epoch 397: f= 657.206, eps=0.005155025
Epoch 398: f= 657.190, eps=0.005412776
Epoch 399: f= 657.173, eps=0.005683415
Epoch 400: f= 657.156, eps=0.005967586
Epoch 401: f= 657.138, eps=0.006265965
Epoch 402: f= 657.118, eps=0.006579263

Epoch 403: f= 657.098, eps=0.006908226
Epoch 404: f= 657.077, eps=0.007253638
Epoch 405: f= 657.054, eps=0.007616320
Epoch 406: f= 657.031, eps=0.007997136
Epoch 407: f= 657.007, eps=0.008396992
Epoch 408: f= 656.981, eps=0.008816842
Epoch 409: f= 656.954, eps=0.009257684
Epoch 410: f= 656.926, eps=0.009720568
Epoch 411: f= 656.896, eps=0.010206597
Epoch 412: f= 656.866, eps=0.010716927
Epoch 413: f= 656.838, eps=0.011252773
Epoch 414: f= 656.871, eps=0.005626387
Epoch 415: f= 656.908, eps=0.002813193
Epoch 416: f= 656.776, eps=0.002953853
Epoch 417: f= 656.765, eps=0.003101546
Epoch 418: f= 656.755, eps=0.003256623
Epoch 419: f= 656.745, eps=0.003419454
Epoch 420: f= 656.735, eps=0.003590427
Epoch 421: f= 656.724, eps=0.003769948
Epoch 422: f= 656.713, eps=0.003958445
Epoch 423: f= 656.701, eps=0.004156368
Epoch 424: f= 656.689, eps=0.004364186
Epoch 425: f= 656.676, eps=0.004582395
Epoch 426: f= 656.662, eps=0.004811515
Epoch 427: f= 656.648, eps=0.005052091
Epoch 428: f= 656.632, eps=0.005304695
Epoch 429: f= 656.617, eps=0.005569930
Epoch 430: f= 656.600, eps=0.005848427
Epoch 431: f= 656.583, eps=0.006140848
Epoch 432: f= 656.564, eps=0.006447890
Epoch 433: f= 656.545, eps=0.006770285
Epoch 434: f= 656.525, eps=0.007108799
Epoch 435: f= 656.504, eps=0.007464239
Epoch 436: f= 656.482, eps=0.007837451
Epoch 437: f= 656.459, eps=0.008229324
Epoch 438: f= 656.435, eps=0.008640790
Epoch 439: f= 656.410, eps=0.009072829
Epoch 440: f= 656.388, eps=0.009526471
Epoch 441: f= 656.406, eps=0.004763235
Epoch 442: f= 656.387, eps=0.005001397
Epoch 443: f= 656.379, eps=0.005251467
Epoch 444: f= 656.381, eps=0.002625734
Epoch 445: f= 656.303, eps=0.002757020
Epoch 446: f= 656.295, eps=0.002894871
Epoch 447: f= 656.286, eps=0.003039615
Epoch 448: f= 656.277, eps=0.003191596
Epoch 449: f= 656.268, eps=0.003351175
Epoch 450: f= 656.258, eps=0.003518734

Epoch 451: f= 656.248, eps=0.003694671
Epoch 452: f= 656.237, eps=0.003879404
Epoch 453: f= 656.226, eps=0.004073375
Epoch 454: f= 656.214, eps=0.004277043
Epoch 455: f= 656.202, eps=0.004490895
Epoch 456: f= 656.189, eps=0.004715440
Epoch 457: f= 656.175, eps=0.004951212
Epoch 458: f= 656.161, eps=0.005198773
Epoch 459: f= 656.145, eps=0.005458711
Epoch 460: f= 656.130, eps=0.005731647
Epoch 461: f= 656.113, eps=0.006018229
Epoch 462: f= 656.096, eps=0.006319141
Epoch 463: f= 656.077, eps=0.006635098
Epoch 464: f= 656.058, eps=0.006966853
Epoch 465: f= 656.038, eps=0.007315195
Epoch 466: f= 656.017, eps=0.007680955
Epoch 467: f= 655.995, eps=0.008065003
Epoch 468: f= 655.972, eps=0.008468253
Epoch 469: f= 655.948, eps=0.008891666
Epoch 470: f= 655.923, eps=0.009336249
Epoch 471: f= 655.896, eps=0.009803061
Epoch 472: f= 655.868, eps=0.010293215
Epoch 473: f= 655.841, eps=0.010807875
Epoch 474: f= 655.835, eps=0.011348269
Epoch 475: f= 656.135, eps=0.005674135
Epoch 476: f= 656.301, eps=0.002837067
Epoch 477: f= 655.760, eps=0.002978921
Epoch 478: f= 655.744, eps=0.003127867
Epoch 479: f= 655.735, eps=0.003284260
Epoch 480: f= 655.725, eps=0.003448473
Epoch 481: f= 655.716, eps=0.003620897
Epoch 482: f= 655.705, eps=0.003801941
Epoch 483: f= 655.695, eps=0.003992039
Epoch 484: f= 655.684, eps=0.004191640
Epoch 485: f= 655.672, eps=0.004401222
Epoch 486: f= 655.659, eps=0.004621284
Epoch 487: f= 655.646, eps=0.004852348
Epoch 488: f= 655.633, eps=0.005094965
Epoch 489: f= 655.619, eps=0.005349713
Epoch 490: f= 655.604, eps=0.005617199
Epoch 491: f= 655.588, eps=0.005898059
Epoch 492: f= 655.571, eps=0.006192962
Epoch 493: f= 655.554, eps=0.006502610
Epoch 494: f= 655.536, eps=0.006827741
Epoch 495: f= 655.517, eps=0.007169128
Epoch 496: f= 655.497, eps=0.007527584
Epoch 497: f= 655.476, eps=0.007903963
Epoch 498: f= 655.454, eps=0.008299161

Epoch 499: f= 655.432, eps=0.008714119
Result after 500 epochs: f=655.413496469947
Epoch 0: f= 6636.544, eps=0.010000000
Epoch 1: f= 4218.624, eps=0.010500000
Epoch 2: f= 2658.502, eps=0.011025000
Epoch 3: f= 1926.666, eps=0.011576250
Epoch 4: f= 1449.805, eps=0.012155063
Epoch 5: f= 1207.714, eps=0.012762816
Epoch 6: f= 1052.586, eps=0.013400956
Epoch 7: f= 957.321, eps=0.014071004
Epoch 8: f= 899.611, eps=0.014774554
Epoch 9: f= 882.634, eps=0.015513282
Epoch 10: f= 1015.190, eps=0.007756641
Epoch 11: f= 841.020, eps=0.008144473
Epoch 12: f= 806.237, eps=0.008551697
Epoch 13: f= 823.099, eps=0.004275848
Epoch 14: f= 746.486, eps=0.004489641
Epoch 15: f= 735.810, eps=0.004714123
Epoch 16: f= 729.776, eps=0.004949829
Epoch 17: f= 724.465, eps=0.005197320
Epoch 18: f= 719.410, eps=0.005457186
Epoch 19: f= 714.572, eps=0.005730046
Epoch 20: f= 709.945, eps=0.006016548
Epoch 21: f= 705.535, eps=0.006317375
Epoch 22: f= 701.350, eps=0.006633244
Epoch 23: f= 697.412, eps=0.006964906
Epoch 24: f= 693.781, eps=0.007313152
Epoch 25: f= 690.670, eps=0.007678809
Epoch 26: f= 688.746, eps=0.008062750
Epoch 27: f= 688.785, eps=0.004031375
Epoch 28: f= 682.821, eps=0.004232944
Epoch 29: f= 681.344, eps=0.004444591
Epoch 30: f= 680.005, eps=0.004666820
Epoch 31: f= 678.724, eps=0.004900161
Epoch 32: f= 677.494, eps=0.005145169
Epoch 33: f= 676.315, eps=0.005402428
Epoch 34: f= 675.202, eps=0.005672549
Epoch 35: f= 674.176, eps=0.005956177
Epoch 36: f= 673.301, eps=0.006253986
Epoch 37: f= 672.684, eps=0.006566685
Epoch 38: f= 672.603, eps=0.006895019
Epoch 39: f= 673.096, eps=0.003447510
Epoch 40: f= 669.981, eps=0.003619885
Epoch 41: f= 669.557, eps=0.003800879
Epoch 42: f= 669.189, eps=0.003990923
Epoch 43: f= 668.837, eps=0.004190469
Epoch 44: f= 668.497, eps=0.004399993
Epoch 45: f= 668.168, eps=0.004619993

Epoch	46:	f=	667.852,	eps=0.004850992
Epoch	47:	f=	667.549,	eps=0.005093542
Epoch	48:	f=	667.260,	eps=0.005348219
Epoch	49:	f=	666.986,	eps=0.005615630
Epoch	50:	f=	666.728,	eps=0.005896411
Epoch	51:	f=	666.487,	eps=0.006191232
Epoch	52:	f=	666.267,	eps=0.006500794
Epoch	53:	f=	666.074,	eps=0.006825833
Epoch	54:	f=	665.940,	eps=0.007167125
Epoch	55:	f=	665.996,	eps=0.003583562
Epoch	56:	f=	665.656,	eps=0.003762741
Epoch	57:	f=	665.532,	eps=0.003950878
Epoch	58:	f=	665.443,	eps=0.004148421
Epoch	59:	f=	665.362,	eps=0.004355843
Epoch	60:	f=	665.286,	eps=0.004573635
Epoch	61:	f=	665.211,	eps=0.004802316
Epoch	62:	f=	665.139,	eps=0.005042432
Epoch	63:	f=	665.068,	eps=0.005294554
Epoch	64:	f=	665.000,	eps=0.005559282
Epoch	65:	f=	664.934,	eps=0.005837246
Epoch	66:	f=	664.873,	eps=0.006129108
Epoch	67:	f=	664.823,	eps=0.006435563
Epoch	68:	f=	664.805,	eps=0.006757341
Epoch	69:	f=	664.895,	eps=0.003378671
Epoch	70:	f=	664.671,	eps=0.003547604
Epoch	71:	f=	664.615,	eps=0.003724984
Epoch	72:	f=	664.579,	eps=0.003911234
Epoch	73:	f=	664.546,	eps=0.004106795
Epoch	74:	f=	664.513,	eps=0.004312135
Epoch	75:	f=	664.480,	eps=0.004527742
Epoch	76:	f=	664.446,	eps=0.004754129
Epoch	77:	f=	664.412,	eps=0.004991835
Epoch	78:	f=	664.377,	eps=0.005241427
Epoch	79:	f=	664.341,	eps=0.005503499
Epoch	80:	f=	664.305,	eps=0.005778674
Epoch	81:	f=	664.268,	eps=0.006067607
Epoch	82:	f=	664.231,	eps=0.006370988
Epoch	83:	f=	664.195,	eps=0.006689537
Epoch	84:	f=	664.167,	eps=0.007024014
Epoch	85:	f=	664.173,	eps=0.003512007
Epoch	86:	f=	664.101,	eps=0.003687607
Epoch	87:	f=	664.070,	eps=0.003871988
Epoch	88:	f=	664.046,	eps=0.004065587
Epoch	89:	f=	664.022,	eps=0.004268866
Epoch	90:	f=	663.999,	eps=0.004482310
Epoch	91:	f=	663.974,	eps=0.004706425
Epoch	92:	f=	663.948,	eps=0.004941746
Epoch	93:	f=	663.922,	eps=0.005188834

Epoch 94: f= 663.894, eps=0.005448275
Epoch 95: f= 663.865, eps=0.005720689
Epoch 96: f= 663.836, eps=0.006006724
Epoch 97: f= 663.806, eps=0.006307060
Epoch 98: f= 663.778, eps=0.006622413
Epoch 99: f= 663.758, eps=0.006953533
Epoch 100: f= 663.775, eps=0.003476767
Epoch 101: f= 663.698, eps=0.003650605
Epoch 102: f= 663.670, eps=0.003833135
Epoch 103: f= 663.649, eps=0.004024792
Epoch 104: f= 663.628, eps=0.004226032
Epoch 105: f= 663.607, eps=0.004437333
Epoch 106: f= 663.585, eps=0.004659200
Epoch 107: f= 663.562, eps=0.004892160
Epoch 108: f= 663.538, eps=0.005136768
Epoch 109: f= 663.514, eps=0.005393606
Epoch 110: f= 663.488, eps=0.005663287
Epoch 111: f= 663.461, eps=0.005946451
Epoch 112: f= 663.433, eps=0.006243773
Epoch 113: f= 663.406, eps=0.006555962
Epoch 114: f= 663.383, eps=0.006883760
Epoch 115: f= 663.379, eps=0.007227948
Epoch 116: f= 663.465, eps=0.003613974
Epoch 117: f= 663.322, eps=0.003794673
Epoch 118: f= 663.281, eps=0.003984406
Epoch 119: f= 663.256, eps=0.004183627
Epoch 120: f= 663.235, eps=0.004392808
Epoch 121: f= 663.214, eps=0.004612449
Epoch 122: f= 663.192, eps=0.004843071
Epoch 123: f= 663.170, eps=0.005085225
Epoch 124: f= 663.147, eps=0.005339486
Epoch 125: f= 663.123, eps=0.005606460
Epoch 126: f= 663.100, eps=0.005886783
Epoch 127: f= 663.078, eps=0.006181122
Epoch 128: f= 663.065, eps=0.006490178
Epoch 129: f= 663.080, eps=0.003245089
Epoch 130: f= 663.005, eps=0.003407344
Epoch 131: f= 662.983, eps=0.003577711
Epoch 132: f= 662.966, eps=0.003756596
Epoch 133: f= 662.949, eps=0.003944426
Epoch 134: f= 662.931, eps=0.004141647
Epoch 135: f= 662.913, eps=0.004348730
Epoch 136: f= 662.893, eps=0.004566166
Epoch 137: f= 662.873, eps=0.004794475
Epoch 138: f= 662.852, eps=0.005034198
Epoch 139: f= 662.830, eps=0.005285908
Epoch 140: f= 662.807, eps=0.005550204
Epoch 141: f= 662.782, eps=0.005827714

Epoch 142: f= 662.757, eps=0.006119100
Epoch 143: f= 662.730, eps=0.006425055
Epoch 144: f= 662.703, eps=0.006746307
Epoch 145: f= 662.674, eps=0.007083623
Epoch 146: f= 662.647, eps=0.007437804
Epoch 147: f= 662.632, eps=0.007809694
Epoch 148: f= 662.687, eps=0.003904847
Epoch 149: f= 662.598, eps=0.004100089
Epoch 150: f= 662.561, eps=0.004305094
Epoch 151: f= 662.535, eps=0.004520348
Epoch 152: f= 662.514, eps=0.004746366
Epoch 153: f= 662.493, eps=0.004983684
Epoch 154: f= 662.473, eps=0.005232868
Epoch 155: f= 662.454, eps=0.005494512
Epoch 156: f= 662.439, eps=0.005769237
Epoch 157: f= 662.434, eps=0.006057699
Epoch 158: f= 662.459, eps=0.003028850
Epoch 159: f= 662.361, eps=0.003180292
Epoch 160: f= 662.343, eps=0.003339307
Epoch 161: f= 662.328, eps=0.003506272
Epoch 162: f= 662.314, eps=0.003681586
Epoch 163: f= 662.298, eps=0.003865665
Epoch 164: f= 662.282, eps=0.004058948
Epoch 165: f= 662.265, eps=0.004261896
Epoch 166: f= 662.248, eps=0.004474990
Epoch 167: f= 662.229, eps=0.004698740
Epoch 168: f= 662.210, eps=0.004933677
Epoch 169: f= 662.189, eps=0.005180361
Epoch 170: f= 662.168, eps=0.005439379
Epoch 171: f= 662.146, eps=0.005711348
Epoch 172: f= 662.122, eps=0.005996915
Epoch 173: f= 662.098, eps=0.006296761
Epoch 174: f= 662.072, eps=0.006611599
Epoch 175: f= 662.045, eps=0.006942179
Epoch 176: f= 662.017, eps=0.007289288
Epoch 177: f= 661.987, eps=0.007653752
Epoch 178: f= 661.958, eps=0.008036440
Epoch 179: f= 661.932, eps=0.008438262
Epoch 180: f= 661.942, eps=0.004219131
Epoch 181: f= 661.901, eps=0.004430087
Epoch 182: f= 661.875, eps=0.004651592
Epoch 183: f= 661.853, eps=0.004884171
Epoch 184: f= 661.834, eps=0.005128380
Epoch 185: f= 661.818, eps=0.005384799
Epoch 186: f= 661.809, eps=0.005654039
Epoch 187: f= 661.812, eps=0.002827019
Epoch 188: f= 661.743, eps=0.002968370
Epoch 189: f= 661.730, eps=0.003116789

Epoch 190: f= 661.717, eps=0.003272628
Epoch 191: f= 661.704, eps=0.003436260
Epoch 192: f= 661.691, eps=0.003608073
Epoch 193: f= 661.676, eps=0.003788476
Epoch 194: f= 661.662, eps=0.003977900
Epoch 195: f= 661.646, eps=0.004176795
Epoch 196: f= 661.629, eps=0.004385635
Epoch 197: f= 661.612, eps=0.004604917
Epoch 198: f= 661.594, eps=0.004835163
Epoch 199: f= 661.575, eps=0.005076921
Epoch 200: f= 661.555, eps=0.005330767
Epoch 201: f= 661.535, eps=0.005597305
Epoch 202: f= 661.513, eps=0.005877170
Epoch 203: f= 661.490, eps=0.006171029
Epoch 204: f= 661.466, eps=0.006479580
Epoch 205: f= 661.441, eps=0.006803559
Epoch 206: f= 661.415, eps=0.007143737
Epoch 207: f= 661.387, eps=0.007500924
Epoch 208: f= 661.359, eps=0.007875970
Epoch 209: f= 661.328, eps=0.008269769
Epoch 210: f= 661.297, eps=0.008683257
Epoch 211: f= 661.265, eps=0.009117420
Epoch 212: f= 661.237, eps=0.009573291
Epoch 213: f= 661.264, eps=0.004786646
Epoch 214: f= 661.243, eps=0.005025978
Epoch 215: f= 661.232, eps=0.005277277
Epoch 216: f= 661.242, eps=0.002638638
Epoch 217: f= 661.126, eps=0.002770570
Epoch 218: f= 661.115, eps=0.002909099
Epoch 219: f= 661.104, eps=0.003054554
Epoch 220: f= 661.093, eps=0.003207282
Epoch 221: f= 661.081, eps=0.003367646
Epoch 222: f= 661.068, eps=0.003536028
Epoch 223: f= 661.055, eps=0.003712829
Epoch 224: f= 661.041, eps=0.003898471
Epoch 225: f= 661.027, eps=0.004093394
Epoch 226: f= 661.011, eps=0.004298064
Epoch 227: f= 660.995, eps=0.004512967
Epoch 228: f= 660.979, eps=0.004738616
Epoch 229: f= 660.961, eps=0.004975546
Epoch 230: f= 660.943, eps=0.005224324
Epoch 231: f= 660.923, eps=0.005485540
Epoch 232: f= 660.903, eps=0.005759817
Epoch 233: f= 660.882, eps=0.006047808
Epoch 234: f= 660.859, eps=0.006350198
Epoch 235: f= 660.836, eps=0.006667708
Epoch 236: f= 660.811, eps=0.007001093
Epoch 237: f= 660.786, eps=0.007351148

Epoch 238: f= 660.759, eps=0.007718705
Epoch 239: f= 660.731, eps=0.008104641
Epoch 240: f= 660.701, eps=0.008509873
Epoch 241: f= 660.670, eps=0.008935366
Epoch 242: f= 660.638, eps=0.009382135
Epoch 243: f= 660.604, eps=0.009851241
Epoch 244: f= 660.569, eps=0.010343803
Epoch 245: f= 660.537, eps=0.010860994
Epoch 246: f= 660.555, eps=0.005430497
Epoch 247: f= 660.566, eps=0.002715248
Epoch 248: f= 660.465, eps=0.002851011
Epoch 249: f= 660.453, eps=0.002993561
Epoch 250: f= 660.443, eps=0.003143239
Epoch 251: f= 660.432, eps=0.003300401
Epoch 252: f= 660.420, eps=0.003465421
Epoch 253: f= 660.407, eps=0.003638693
Epoch 254: f= 660.395, eps=0.003820627
Epoch 255: f= 660.381, eps=0.004011659
Epoch 256: f= 660.367, eps=0.004212241
Epoch 257: f= 660.352, eps=0.004422854
Epoch 258: f= 660.336, eps=0.004643996
Epoch 259: f= 660.320, eps=0.004876196
Epoch 260: f= 660.303, eps=0.005120006
Epoch 261: f= 660.285, eps=0.005376006
Epoch 262: f= 660.266, eps=0.005644806
Epoch 263: f= 660.246, eps=0.005927047
Epoch 264: f= 660.225, eps=0.006223399
Epoch 265: f= 660.204, eps=0.006534569
Epoch 266: f= 660.181, eps=0.006861297
Epoch 267: f= 660.157, eps=0.007204362
Epoch 268: f= 660.132, eps=0.007564580
Epoch 269: f= 660.106, eps=0.007942809
Epoch 270: f= 660.078, eps=0.008339950
Epoch 271: f= 660.049, eps=0.008756947
Epoch 272: f= 660.019, eps=0.009194795
Epoch 273: f= 659.988, eps=0.009654535
Epoch 274: f= 659.959, eps=0.010137261
Epoch 275: f= 659.968, eps=0.005068631
Epoch 276: f= 659.960, eps=0.005322062
Epoch 277: f= 659.965, eps=0.002661031
Epoch 278: f= 659.876, eps=0.002794083
Epoch 279: f= 659.866, eps=0.002933787
Epoch 280: f= 659.856, eps=0.003080476
Epoch 281: f= 659.845, eps=0.003234500
Epoch 282: f= 659.834, eps=0.003396225
Epoch 283: f= 659.823, eps=0.003566036
Epoch 284: f= 659.811, eps=0.003744338
Epoch 285: f= 659.798, eps=0.003931555

Epoch 286: f= 659.785, eps=0.004128133
Epoch 287: f= 659.771, eps=0.004334539
Epoch 288: f= 659.756, eps=0.004551266
Epoch 289: f= 659.741, eps=0.004778830
Epoch 290: f= 659.725, eps=0.005017771
Epoch 291: f= 659.708, eps=0.005268660
Epoch 292: f= 659.690, eps=0.005532093
Epoch 293: f= 659.672, eps=0.005808697
Epoch 294: f= 659.652, eps=0.006099132
Epoch 295: f= 659.632, eps=0.006404089
Epoch 296: f= 659.610, eps=0.006724293
Epoch 297: f= 659.588, eps=0.007060508
Epoch 298: f= 659.565, eps=0.007413533
Epoch 299: f= 659.540, eps=0.007784210
Epoch 300: f= 659.514, eps=0.008173420
Epoch 301: f= 659.487, eps=0.008582091
Epoch 302: f= 659.459, eps=0.009011196
Epoch 303: f= 659.429, eps=0.009461756
Epoch 304: f= 659.398, eps=0.009934843
Epoch 305: f= 659.368, eps=0.010431585
Epoch 306: f= 659.355, eps=0.010953165
Epoch 307: f= 659.582, eps=0.005476582
Epoch 308: f= 659.696, eps=0.002738291
Epoch 309: f= 659.271, eps=0.002875206
Epoch 310: f= 659.260, eps=0.003018966
Epoch 311: f= 659.250, eps=0.003169914
Epoch 312: f= 659.240, eps=0.003328410
Epoch 313: f= 659.229, eps=0.003494831
Epoch 314: f= 659.218, eps=0.003669572
Epoch 315: f= 659.206, eps=0.003853051
Epoch 316: f= 659.193, eps=0.004045703
Epoch 317: f= 659.180, eps=0.004247988
Epoch 318: f= 659.167, eps=0.004460388
Epoch 319: f= 659.152, eps=0.004683407
Epoch 320: f= 659.137, eps=0.004917578
Epoch 321: f= 659.121, eps=0.005163456
Epoch 322: f= 659.105, eps=0.005421629
Epoch 323: f= 659.087, eps=0.005692711
Epoch 324: f= 659.069, eps=0.005977346
Epoch 325: f= 659.050, eps=0.006276214
Epoch 326: f= 659.030, eps=0.006590024
Epoch 327: f= 659.009, eps=0.006919525
Epoch 328: f= 658.987, eps=0.007265502
Epoch 329: f= 658.964, eps=0.007628777
Epoch 330: f= 658.940, eps=0.008010216
Epoch 331: f= 658.915, eps=0.008410726
Epoch 332: f= 658.888, eps=0.008831263
Epoch 333: f= 658.861, eps=0.009272826

Epoch 334: f= 658.833, eps=0.009736467
Epoch 335: f= 658.816, eps=0.010223291
Epoch 336: f= 658.932, eps=0.005111645
Epoch 337: f= 658.937, eps=0.002555823
Epoch 338: f= 658.745, eps=0.002683614
Epoch 339: f= 658.736, eps=0.002817794
Epoch 340: f= 658.728, eps=0.002958684
Epoch 341: f= 658.718, eps=0.003106618
Epoch 342: f= 658.709, eps=0.003261949
Epoch 343: f= 658.699, eps=0.003425047
Epoch 344: f= 658.688, eps=0.003596299
Epoch 345: f= 658.677, eps=0.003776114
Epoch 346: f= 658.665, eps=0.003964920
Epoch 347: f= 658.653, eps=0.004163166
Epoch 348: f= 658.640, eps=0.004371324
Epoch 349: f= 658.626, eps=0.004589890
Epoch 350: f= 658.612, eps=0.004819385
Epoch 351: f= 658.597, eps=0.005060354
Epoch 352: f= 658.582, eps=0.005313372
Epoch 353: f= 658.566, eps=0.005579040
Epoch 354: f= 658.548, eps=0.005857992
Epoch 355: f= 658.530, eps=0.006150892
Epoch 356: f= 658.512, eps=0.006458437
Epoch 357: f= 658.492, eps=0.006781358
Epoch 358: f= 658.471, eps=0.007120426
Epoch 359: f= 658.449, eps=0.007476448
Epoch 360: f= 658.427, eps=0.007850270
Epoch 361: f= 658.403, eps=0.008242783
Epoch 362: f= 658.378, eps=0.008654923
Epoch 363: f= 658.352, eps=0.009087669
Epoch 364: f= 658.324, eps=0.009542052
Epoch 365: f= 658.295, eps=0.010019155
Epoch 366: f= 658.265, eps=0.010520113
Epoch 367: f= 658.234, eps=0.011046118
Epoch 368: f= 658.207, eps=0.011598424
Epoch 369: f= 658.252, eps=0.005799212
Epoch 370: f= 658.313, eps=0.002899606
Epoch 371: f= 658.145, eps=0.003044586
Epoch 372: f= 658.131, eps=0.003196816
Epoch 373: f= 658.122, eps=0.003356656
Epoch 374: f= 658.112, eps=0.003524489
Epoch 375: f= 658.101, eps=0.003700714
Epoch 376: f= 658.090, eps=0.003885749
Epoch 377: f= 658.079, eps=0.004080037
Epoch 378: f= 658.067, eps=0.004284039
Epoch 379: f= 658.054, eps=0.004498241
Epoch 380: f= 658.041, eps=0.004723153
Epoch 381: f= 658.027, eps=0.004959310

Epoch 382: f= 658.012, eps=0.005207276
Epoch 383: f= 657.997, eps=0.005467640
Epoch 384: f= 657.981, eps=0.005741022
Epoch 385: f= 657.964, eps=0.006028073
Epoch 386: f= 657.946, eps=0.006329476
Epoch 387: f= 657.928, eps=0.006645950
Epoch 388: f= 657.908, eps=0.006978248
Epoch 389: f= 657.888, eps=0.007327160
Epoch 390: f= 657.866, eps=0.007693518
Epoch 391: f= 657.844, eps=0.008078194
Epoch 392: f= 657.821, eps=0.008482104
Epoch 393: f= 657.801, eps=0.008906209
Epoch 394: f= 657.806, eps=0.004453104
Epoch 395: f= 657.782, eps=0.004675760
Epoch 396: f= 657.766, eps=0.004909548
Epoch 397: f= 657.752, eps=0.005155025
Epoch 398: f= 657.744, eps=0.005412776
Epoch 399: f= 657.744, eps=0.005683415
Epoch 400: f= 657.764, eps=0.002841708
Epoch 401: f= 657.677, eps=0.002983793
Epoch 402: f= 657.666, eps=0.003132983
Epoch 403: f= 657.657, eps=0.003289632
Epoch 404: f= 657.648, eps=0.003454113
Epoch 405: f= 657.638, eps=0.003626819
Epoch 406: f= 657.628, eps=0.003808160
Epoch 407: f= 657.617, eps=0.003998568
Epoch 408: f= 657.605, eps=0.004198496
Epoch 409: f= 657.593, eps=0.004408421
Epoch 410: f= 657.581, eps=0.004628842
Epoch 411: f= 657.567, eps=0.004860284
Epoch 412: f= 657.554, eps=0.005103298
Epoch 413: f= 657.539, eps=0.005358463
Epoch 414: f= 657.524, eps=0.005626387
Epoch 415: f= 657.508, eps=0.005907706
Epoch 416: f= 657.491, eps=0.006203091
Epoch 417: f= 657.474, eps=0.006513246
Epoch 418: f= 657.455, eps=0.006838908
Epoch 419: f= 657.436, eps=0.007180853
Epoch 420: f= 657.416, eps=0.007539896
Epoch 421: f= 657.395, eps=0.007916891
Epoch 422: f= 657.372, eps=0.008312735
Epoch 423: f= 657.349, eps=0.008728372
Epoch 424: f= 657.327, eps=0.009164791
Epoch 425: f= 657.314, eps=0.009623030
Epoch 426: f= 657.407, eps=0.004811515
Epoch 427: f= 657.380, eps=0.005052091
Epoch 428: f= 657.385, eps=0.002526045
Epoch 429: f= 657.238, eps=0.002652348

Epoch 430: f= 657.231, eps=0.002784965
Epoch 431: f= 657.223, eps=0.002924213
Epoch 432: f= 657.215, eps=0.003070424
Epoch 433: f= 657.206, eps=0.003223945
Epoch 434: f= 657.197, eps=0.003385142
Epoch 435: f= 657.188, eps=0.003554400
Epoch 436: f= 657.178, eps=0.003732120
Epoch 437: f= 657.168, eps=0.003918726
Epoch 438: f= 657.157, eps=0.004114662
Epoch 439: f= 657.146, eps=0.004320395
Epoch 440: f= 657.134, eps=0.004536415
Epoch 441: f= 657.121, eps=0.004763235
Epoch 442: f= 657.108, eps=0.005001397
Epoch 443: f= 657.094, eps=0.005251467
Epoch 444: f= 657.080, eps=0.005514040
Epoch 445: f= 657.065, eps=0.005789742
Epoch 446: f= 657.049, eps=0.006079230
Epoch 447: f= 657.032, eps=0.006383191
Epoch 448: f= 657.015, eps=0.006702351
Epoch 449: f= 656.997, eps=0.007037468
Epoch 450: f= 656.978, eps=0.007389342
Epoch 451: f= 656.958, eps=0.007758809
Epoch 452: f= 656.936, eps=0.008146749
Epoch 453: f= 656.914, eps=0.008554086
Epoch 454: f= 656.891, eps=0.008981791
Epoch 455: f= 656.867, eps=0.009430880
Epoch 456: f= 656.842, eps=0.009902424
Epoch 457: f= 656.815, eps=0.010397546
Epoch 458: f= 656.787, eps=0.010917423
Epoch 459: f= 656.758, eps=0.011463294
Epoch 460: f= 656.729, eps=0.012036459
Epoch 461: f= 656.721, eps=0.012638282
Epoch 462: f= 657.104, eps=0.006319141
Epoch 463: f= 657.572, eps=0.003159570
Epoch 464: f= 656.679, eps=0.003317549
Epoch 465: f= 656.633, eps=0.003483426
Epoch 466: f= 656.619, eps=0.003657598
Epoch 467: f= 656.609, eps=0.003840478
Epoch 468: f= 656.599, eps=0.004032501
Epoch 469: f= 656.588, eps=0.004234127
Epoch 470: f= 656.577, eps=0.004445833
Epoch 471: f= 656.565, eps=0.004668125
Epoch 472: f= 656.553, eps=0.004901531
Epoch 473: f= 656.540, eps=0.005146607
Epoch 474: f= 656.526, eps=0.005403938
Epoch 475: f= 656.512, eps=0.005674135
Epoch 476: f= 656.497, eps=0.005957841
Epoch 477: f= 656.482, eps=0.006255733

Epoch 478: f= 656.466, eps=0.006568520
 Epoch 479: f= 656.449, eps=0.006896946
 Epoch 480: f= 656.434, eps=0.007241793
 Epoch 481: f= 656.425, eps=0.007603883
 Epoch 482: f= 656.457, eps=0.003801941
 Epoch 483: f= 656.402, eps=0.003992039
 Epoch 484: f= 656.380, eps=0.004191640
 Epoch 485: f= 656.365, eps=0.004401222
 Epoch 486: f= 656.352, eps=0.004621284
 Epoch 487: f= 656.340, eps=0.004852348
 Epoch 488: f= 656.327, eps=0.005094965
 Epoch 489: f= 656.314, eps=0.005349713
 Epoch 490: f= 656.302, eps=0.005617199
 Epoch 491: f= 656.292, eps=0.005898059
 Epoch 492: f= 656.286, eps=0.006192962
 Epoch 493: f= 656.296, eps=0.003096481
 Epoch 494: f= 656.247, eps=0.003251305
 Epoch 495: f= 656.236, eps=0.003413870
 Epoch 496: f= 656.227, eps=0.003584564
 Epoch 497: f= 656.217, eps=0.003763792
 Epoch 498: f= 656.208, eps=0.003951982
 Epoch 499: f= 656.198, eps=0.004149581
 Result after 500 epochs: f=656.1869767255795
 Epoch 0: f= 6639.565, eps=0.010000000
 Epoch 1: f= 4233.632, eps=0.010500000
 Epoch 2: f= 2667.324, eps=0.011025000
 Epoch 3: f= 1931.401, eps=0.011576250
 Epoch 4: f= 1452.545, eps=0.012155063
 Epoch 5: f= 1209.329, eps=0.012762816
 Epoch 6: f= 1053.408, eps=0.013400956
 Epoch 7: f= 957.678, eps=0.014071004
 Epoch 8: f= 899.563, eps=0.014774554
 Epoch 9: f= 880.065, eps=0.015513282
 Epoch 10: f= 996.169, eps=0.007756641
 Epoch 11: f= 843.339, eps=0.008144473
 Epoch 12: f= 811.849, eps=0.008551697
 Epoch 13: f= 832.190, eps=0.004275848
 Epoch 14: f= 747.520, eps=0.004489641
 Epoch 15: f= 735.848, eps=0.004714123
 Epoch 16: f= 729.721, eps=0.004949829
 Epoch 17: f= 724.428, eps=0.005197320
 Epoch 18: f= 719.411, eps=0.005457186
 Epoch 19: f= 714.622, eps=0.005730046
 Epoch 20: f= 710.053, eps=0.006016548
 Epoch 21: f= 705.708, eps=0.006317375
 Epoch 22: f= 701.601, eps=0.006633244
 Epoch 23: f= 697.759, eps=0.006964906
 Epoch 24: f= 694.274, eps=0.007313152

Epoch	25:	f=	691.447,	eps=0.007678809
Epoch	26:	f=	690.066,	eps=0.008062750
Epoch	27:	f=	690.431,	eps=0.004031375
Epoch	28:	f=	683.569,	eps=0.004232944
Epoch	29:	f=	682.144,	eps=0.004444591
Epoch	30:	f=	680.859,	eps=0.004666820
Epoch	31:	f=	679.635,	eps=0.004900161
Epoch	32:	f=	678.463,	eps=0.005145169
Epoch	33:	f=	677.345,	eps=0.005402428
Epoch	34:	f=	676.294,	eps=0.005672549
Epoch	35:	f=	675.333,	eps=0.005956177
Epoch	36:	f=	674.523,	eps=0.006253986
Epoch	37:	f=	673.975,	eps=0.006566685
Epoch	38:	f=	673.974,	eps=0.006895019
Epoch	39:	f=	674.571,	eps=0.003447510
Epoch	40:	f=	671.438,	eps=0.003619885
Epoch	41:	f=	671.042,	eps=0.003800879
Epoch	42:	f=	670.706,	eps=0.003990923
Epoch	43:	f=	670.387,	eps=0.004190469
Epoch	44:	f=	670.080,	eps=0.004399993
Epoch	45:	f=	669.785,	eps=0.004619993
Epoch	46:	f=	669.503,	eps=0.004850992
Epoch	47:	f=	669.234,	eps=0.005093542
Epoch	48:	f=	668.978,	eps=0.005348219
Epoch	49:	f=	668.738,	eps=0.005615630
Epoch	50:	f=	668.513,	eps=0.005896411
Epoch	51:	f=	668.305,	eps=0.006191232
Epoch	52:	f=	668.116,	eps=0.006500794
Epoch	53:	f=	667.955,	eps=0.006825833
Epoch	54:	f=	667.858,	eps=0.007167125
Epoch	55:	f=	667.970,	eps=0.003583562
Epoch	56:	f=	667.610,	eps=0.003762741
Epoch	57:	f=	667.493,	eps=0.003950878
Epoch	58:	f=	667.415,	eps=0.004148421
Epoch	59:	f=	667.347,	eps=0.004355843
Epoch	60:	f=	667.283,	eps=0.004573635
Epoch	61:	f=	667.221,	eps=0.004802316
Epoch	62:	f=	667.161,	eps=0.005042432
Epoch	63:	f=	667.103,	eps=0.005294554
Epoch	64:	f=	667.047,	eps=0.005559282
Epoch	65:	f=	666.994,	eps=0.005837246
Epoch	66:	f=	666.946,	eps=0.006129108
Epoch	67:	f=	666.911,	eps=0.006435563
Epoch	68:	f=	666.914,	eps=0.003217782
Epoch	69:	f=	666.812,	eps=0.003378671
Epoch	70:	f=	666.780,	eps=0.003547604
Epoch	71:	f=	666.753,	eps=0.003724984
Epoch	72:	f=	666.728,	eps=0.003911234

Epoch 73: f= 666.701, eps=0.004106795
 Epoch 74: f= 666.675, eps=0.004312135
 Epoch 75: f= 666.648, eps=0.004527742
 Epoch 76: f= 666.621, eps=0.004754129
 Epoch 77: f= 666.593, eps=0.004991835
 Epoch 78: f= 666.565, eps=0.005241427
 Epoch 79: f= 666.536, eps=0.005503499
 Epoch 80: f= 666.507, eps=0.005778674
 Epoch 81: f= 666.477, eps=0.006067607
 Epoch 82: f= 666.447, eps=0.006370988
 Epoch 83: f= 666.416, eps=0.006689537
 Epoch 84: f= 666.385, eps=0.007024014
 Epoch 85: f= 666.355, eps=0.007375214
 Epoch 86: f= 666.333, eps=0.007743975
 Epoch 87: f= 666.352, eps=0.003871988
 Epoch 88: f= 666.293, eps=0.004065587
 Epoch 89: f= 666.263, eps=0.004268866
 Epoch 90: f= 666.240, eps=0.004482310
 Epoch 91: f= 666.220, eps=0.004706425
 Epoch 92: f= 666.200, eps=0.004941746
 Epoch 93: f= 666.180, eps=0.005188834
 Epoch 94: f= 666.161, eps=0.005448275
 Epoch 95: f= 666.143, eps=0.005720689
 Epoch 96: f= 666.131, eps=0.006006724
 Epoch 97: f= 666.132, eps=0.003003362
 Epoch 98: f= 666.078, eps=0.003153530
 Epoch 99: f= 666.063, eps=0.003311206
 Epoch 100: f= 666.050, eps=0.003476767
 Epoch 101: f= 666.037, eps=0.003650605
 Epoch 102: f= 666.023, eps=0.003833135
 Epoch 103: f= 666.009, eps=0.004024792
 Epoch 104: f= 665.993, eps=0.004226032
 Epoch 105: f= 665.978, eps=0.004437333
 Epoch 106: f= 665.961, eps=0.004659200
 Epoch 107: f= 665.944, eps=0.004892160
 Epoch 108: f= 665.926, eps=0.005136768
 Epoch 109: f= 665.907, eps=0.005393606
 Epoch 110: f= 665.888, eps=0.005663287
 Epoch 111: f= 665.868, eps=0.005946451
 Epoch 112: f= 665.846, eps=0.006243773
 Epoch 113: f= 665.824, eps=0.006555962
 Epoch 114: f= 665.801, eps=0.006883760
 Epoch 115: f= 665.777, eps=0.007227948
 Epoch 116: f= 665.752, eps=0.007589346
 Epoch 117: f= 665.726, eps=0.007968813
 Epoch 118: f= 665.701, eps=0.008367254
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Epoch 122: f= 665.667, eps=0.004843071
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Epoch 146: f= 665.255, eps=0.007437804
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Epoch 148: f= 665.208, eps=0.008200179
Epoch 149: f= 665.183, eps=0.008610188
Epoch 150: f= 665.157, eps=0.009040697
Epoch 151: f= 665.130, eps=0.009492732
Epoch 152: f= 665.102, eps=0.009967368
Epoch 153: f= 665.077, eps=0.010465737
Epoch 154: f= 665.104, eps=0.005232868
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Epoch 161: f= 664.973, eps=0.003506272
Epoch 162: f= 664.963, eps=0.003681586
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Epoch 164: f= 664.941, eps=0.004058948
Epoch 165: f= 664.929, eps=0.004261896
Epoch 166: f= 664.917, eps=0.004474990
Epoch 167: f= 664.904, eps=0.004698740
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Epoch 209: f= 664.215, eps=0.008269769
Epoch 210: f= 664.196, eps=0.008683257
Epoch 211: f= 664.179, eps=0.009117420
Epoch 212: f= 664.196, eps=0.004558710
Epoch 213: f= 664.174, eps=0.004786646
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Epoch 215: f= 664.155, eps=0.005277277
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Epoch 218: f= 664.090, eps=0.002909099
Epoch 219: f= 664.083, eps=0.003054554
Epoch 220: f= 664.075, eps=0.003207282
Epoch 221: f= 664.068, eps=0.003367646
Epoch 222: f= 664.059, eps=0.003536028
Epoch 223: f= 664.051, eps=0.003712829
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Epoch 235: f= 663.911, eps=0.006667708
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Epoch 244: f= 663.743, eps=0.010343803
Epoch 245: f= 663.723, eps=0.010860994
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Epoch 260: f= 663.577, eps=0.005120006
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Epoch 272: f= 663.404, eps=0.009194795
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Epoch 274: f= 663.370, eps=0.010137261
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Epoch 289: f= 663.242, eps=0.004778830
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Epoch 295: f= 663.177, eps=0.006404089
Epoch 296: f= 663.165, eps=0.006724293
Epoch 297: f= 663.152, eps=0.007060508
Epoch 298: f= 663.138, eps=0.007413533
Epoch 299: f= 663.123, eps=0.007784210
Epoch 300: f= 663.108, eps=0.008173420
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Epoch 302: f= 663.075, eps=0.009011196
Epoch 303: f= 663.058, eps=0.009461756
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Epoch 309: f= 663.032, eps=0.006037932
Epoch 310: f= 663.136, eps=0.003018966
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Epoch 312: f= 662.914, eps=0.003328410

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 Epoch 492: f= 661.392, eps=0.002949030
 Epoch 493: f= 661.389, eps=0.003096481
 Epoch 494: f= 661.385, eps=0.003251305
 Epoch 495: f= 661.381, eps=0.003413870
 Epoch 496: f= 661.377, eps=0.003584564
 Epoch 497: f= 661.373, eps=0.003763792
 Epoch 498: f= 661.368, eps=0.003951982
 Epoch 499: f= 661.363, eps=0.004149581
 Result after 500 epochs: f=661.3584589394447
 Epoch 0: f= 6652.989, eps=0.010000000
 Epoch 1: f= 4300.327, eps=0.010500000
 Epoch 2: f= 2705.946, eps=0.011025000
 Epoch 3: f= 1951.518, eps=0.011576250

Epoch	4:	f=	1463.730,	eps=0.012155063
Epoch	5:	f=	1215.472,	eps=0.012762816
Epoch	6:	f=	1055.995,	eps=0.013400956
Epoch	7:	f=	958.296,	eps=0.014071004
Epoch	8:	f=	899.029,	eps=0.014774554
Epoch	9:	f=	871.206,	eps=0.015513282
Epoch	10:	f=	886.721,	eps=0.007756641
Epoch	11:	f=	820.444,	eps=0.008144473
Epoch	12:	f=	800.657,	eps=0.008551697
Epoch	13:	f=	832.124,	eps=0.004275848
Epoch	14:	f=	746.346,	eps=0.004489641
Epoch	15:	f=	733.413,	eps=0.004714123
Epoch	16:	f=	727.538,	eps=0.004949829
Epoch	17:	f=	722.609,	eps=0.005197320
Epoch	18:	f=	717.979,	eps=0.005457186
Epoch	19:	f=	713.593,	eps=0.005730046
Epoch	20:	f=	709.449,	eps=0.006016548
Epoch	21:	f=	705.556,	eps=0.006317375
Epoch	22:	f=	701.942,	eps=0.006633244
Epoch	23:	f=	698.684,	eps=0.006964906
Epoch	24:	f=	696.021,	eps=0.007313152
Epoch	25:	f=	694.553,	eps=0.007678809
Epoch	26:	f=	695.168,	eps=0.003839405
Epoch	27:	f=	688.767,	eps=0.004031375
Epoch	28:	f=	687.488,	eps=0.004232944
Epoch	29:	f=	686.352,	eps=0.004444591
Epoch	30:	f=	685.272,	eps=0.004666820
Epoch	31:	f=	684.239,	eps=0.004900161
Epoch	32:	f=	683.253,	eps=0.005145169
Epoch	33:	f=	682.319,	eps=0.005402428
Epoch	34:	f=	681.442,	eps=0.005672549
Epoch	35:	f=	680.628,	eps=0.005956177
Epoch	36:	f=	679.890,	eps=0.006253986
Epoch	37:	f=	679.261,	eps=0.006566685
Epoch	38:	f=	678.837,	eps=0.006895019
Epoch	39:	f=	678.917,	eps=0.003447510
Epoch	40:	f=	677.822,	eps=0.003619885
Epoch	41:	f=	677.503,	eps=0.003800879
Epoch	42:	f=	677.262,	eps=0.003990923
Epoch	43:	f=	677.043,	eps=0.004190469
Epoch	44:	f=	676.838,	eps=0.004399993
Epoch	45:	f=	676.645,	eps=0.004619993
Epoch	46:	f=	676.464,	eps=0.004850992
Epoch	47:	f=	676.294,	eps=0.005093542
Epoch	48:	f=	676.138,	eps=0.005348219
Epoch	49:	f=	675.993,	eps=0.005615630
Epoch	50:	f=	675.861,	eps=0.005896411
Epoch	51:	f=	675.744,	eps=0.006191232

Epoch	52:	f=	675.644,	eps=0.006500794
Epoch	53:	f=	675.580,	eps=0.006825833
Epoch	54:	f=	675.615,	eps=0.003412917
Epoch	55:	f=	675.423,	eps=0.003583562
Epoch	56:	f=	675.365,	eps=0.003762741
Epoch	57:	f=	675.324,	eps=0.003950878
Epoch	58:	f=	675.287,	eps=0.004148421
Epoch	59:	f=	675.252,	eps=0.004355843
Epoch	60:	f=	675.218,	eps=0.004573635
Epoch	61:	f=	675.186,	eps=0.004802316
Epoch	62:	f=	675.156,	eps=0.005042432
Epoch	63:	f=	675.126,	eps=0.005294554
Epoch	64:	f=	675.098,	eps=0.005559282
Epoch	65:	f=	675.072,	eps=0.005837246
Epoch	66:	f=	675.047,	eps=0.006129108
Epoch	67:	f=	675.025,	eps=0.006435563
Epoch	68:	f=	675.009,	eps=0.006757341
Epoch	69:	f=	675.013,	eps=0.003378671
Epoch	70:	f=	674.972,	eps=0.003547604
Epoch	71:	f=	674.957,	eps=0.003724984
Epoch	72:	f=	674.945,	eps=0.003911234
Epoch	73:	f=	674.935,	eps=0.004106795
Epoch	74:	f=	674.924,	eps=0.004312135
Epoch	75:	f=	674.914,	eps=0.004527742
Epoch	76:	f=	674.903,	eps=0.004754129
Epoch	77:	f=	674.893,	eps=0.004991835
Epoch	78:	f=	674.883,	eps=0.005241427
Epoch	79:	f=	674.872,	eps=0.005503499
Epoch	80:	f=	674.862,	eps=0.005778674
Epoch	81:	f=	674.851,	eps=0.006067607
Epoch	82:	f=	674.841,	eps=0.006370988
Epoch	83:	f=	674.831,	eps=0.006689537
Epoch	84:	f=	674.824,	eps=0.007024014
Epoch	85:	f=	674.829,	eps=0.003512007
Epoch	86:	f=	674.808,	eps=0.003687607
Epoch	87:	f=	674.799,	eps=0.003871988
Epoch	88:	f=	674.793,	eps=0.004065587
Epoch	89:	f=	674.787,	eps=0.004268866
Epoch	90:	f=	674.781,	eps=0.004482310
Epoch	91:	f=	674.775,	eps=0.004706425
Epoch	92:	f=	674.769,	eps=0.004941746
Epoch	93:	f=	674.762,	eps=0.005188834
Epoch	94:	f=	674.756,	eps=0.005448275
Epoch	95:	f=	674.749,	eps=0.005720689
Epoch	96:	f=	674.742,	eps=0.006006724
Epoch	97:	f=	674.736,	eps=0.006307060
Epoch	98:	f=	674.731,	eps=0.006622413
Epoch	99:	f=	674.730,	eps=0.006953533

Epoch 100: f= 674.748, eps=0.003476767
Epoch 101: f= 674.715, eps=0.003650605
Epoch 102: f= 674.706, eps=0.003833135
Epoch 103: f= 674.701, eps=0.004024792
Epoch 104: f= 674.696, eps=0.004226032
Epoch 105: f= 674.692, eps=0.004437333
Epoch 106: f= 674.687, eps=0.004659200
Epoch 107: f= 674.682, eps=0.004892160
Epoch 108: f= 674.677, eps=0.005136768
Epoch 109: f= 674.672, eps=0.005393606
Epoch 110: f= 674.667, eps=0.005663287
Epoch 111: f= 674.662, eps=0.005946451
Epoch 112: f= 674.657, eps=0.006243773
Epoch 113: f= 674.653, eps=0.006555962
Epoch 114: f= 674.653, eps=0.003277981
Epoch 115: f= 674.642, eps=0.003441880
Epoch 116: f= 674.638, eps=0.003613974
Epoch 117: f= 674.634, eps=0.003794673
Epoch 118: f= 674.631, eps=0.003984406
Epoch 119: f= 674.627, eps=0.004183627
Epoch 120: f= 674.623, eps=0.004392808
Epoch 121: f= 674.620, eps=0.004612449
Epoch 122: f= 674.616, eps=0.004843071
Epoch 123: f= 674.611, eps=0.005085225
Epoch 124: f= 674.607, eps=0.005339486
Epoch 125: f= 674.603, eps=0.005606460
Epoch 126: f= 674.598, eps=0.005886783
Epoch 127: f= 674.593, eps=0.006181122
Epoch 128: f= 674.588, eps=0.006490178
Epoch 129: f= 674.583, eps=0.006814687
Epoch 130: f= 674.578, eps=0.007155422
Epoch 131: f= 674.574, eps=0.007513193
Epoch 132: f= 674.577, eps=0.003756596
Epoch 133: f= 674.567, eps=0.003944426
Epoch 134: f= 674.561, eps=0.004141647
Epoch 135: f= 674.558, eps=0.004348730
Epoch 136: f= 674.554, eps=0.004566166
Epoch 137: f= 674.551, eps=0.004794475
Epoch 138: f= 674.547, eps=0.005034198
Epoch 139: f= 674.543, eps=0.005285908
Epoch 140: f= 674.540, eps=0.005550204
Epoch 141: f= 674.536, eps=0.005827714
Epoch 142: f= 674.534, eps=0.006119100
Epoch 143: f= 674.534, eps=0.006425055
Epoch 144: f= 674.542, eps=0.003212527
Epoch 145: f= 674.522, eps=0.003373154
Epoch 146: f= 674.518, eps=0.003541811
Epoch 147: f= 674.515, eps=0.003718902

Epoch 148: f= 674.513, eps=0.003904847
Epoch 149: f= 674.510, eps=0.004100089
Epoch 150: f= 674.507, eps=0.004305094
Epoch 151: f= 674.504, eps=0.004520348
Epoch 152: f= 674.501, eps=0.004746366
Epoch 153: f= 674.498, eps=0.004983684
Epoch 154: f= 674.495, eps=0.005232868
Epoch 155: f= 674.492, eps=0.005494512
Epoch 156: f= 674.488, eps=0.005769237
Epoch 157: f= 674.485, eps=0.006057699
Epoch 158: f= 674.481, eps=0.006360584
Epoch 159: f= 674.477, eps=0.006678613
Epoch 160: f= 674.473, eps=0.007012544
Epoch 161: f= 674.470, eps=0.007363171
Epoch 162: f= 674.469, eps=0.007731330
Epoch 163: f= 674.485, eps=0.003865665
Epoch 164: f= 674.467, eps=0.004058948
Epoch 165: f= 674.459, eps=0.004261896
Epoch 166: f= 674.455, eps=0.004474990
Epoch 167: f= 674.452, eps=0.004698740
Epoch 168: f= 674.449, eps=0.004933677
Epoch 169: f= 674.447, eps=0.005180361
Epoch 170: f= 674.445, eps=0.005439379
Epoch 171: f= 674.443, eps=0.005711348
Epoch 172: f= 674.445, eps=0.002855674
Epoch 173: f= 674.434, eps=0.002998458
Epoch 174: f= 674.432, eps=0.003148380
Epoch 175: f= 674.431, eps=0.003305799
Epoch 176: f= 674.429, eps=0.003471089
Epoch 177: f= 674.427, eps=0.003644644
Epoch 178: f= 674.425, eps=0.003826876
Epoch 179: f= 674.423, eps=0.004018220
Epoch 180: f= 674.421, eps=0.004219131
Epoch 181: f= 674.419, eps=0.004430087
Epoch 182: f= 674.416, eps=0.004651592
Epoch 183: f= 674.414, eps=0.004884171
Epoch 184: f= 674.411, eps=0.005128380
Epoch 185: f= 674.409, eps=0.005384799
Epoch 186: f= 674.406, eps=0.005654039
Epoch 187: f= 674.403, eps=0.005936741
Epoch 188: f= 674.400, eps=0.006233578
Epoch 189: f= 674.397, eps=0.006545257
Epoch 190: f= 674.394, eps=0.006872520
Epoch 191: f= 674.391, eps=0.007216146
Epoch 192: f= 674.387, eps=0.007576953
Epoch 193: f= 674.384, eps=0.007955801
Epoch 194: f= 674.380, eps=0.008353591
Epoch 195: f= 674.377, eps=0.008771270

Epoch 196: f= 674.374, eps=0.009209834
Epoch 197: f= 674.378, eps=0.004604917
Epoch 198: f= 674.375, eps=0.004835163
Epoch 199: f= 674.373, eps=0.005076921
Epoch 200: f= 674.373, eps=0.002538460
Epoch 201: f= 674.361, eps=0.002665383
Epoch 202: f= 674.360, eps=0.002798653
Epoch 203: f= 674.359, eps=0.002938585
Epoch 204: f= 674.357, eps=0.003085514
Epoch 205: f= 674.356, eps=0.003239790
Epoch 206: f= 674.355, eps=0.003401780
Epoch 207: f= 674.353, eps=0.003571869
Epoch 208: f= 674.352, eps=0.003750462
Epoch 209: f= 674.350, eps=0.003937985
Epoch 210: f= 674.349, eps=0.004134885
Epoch 211: f= 674.347, eps=0.004341629
Epoch 212: f= 674.345, eps=0.004558710
Epoch 213: f= 674.343, eps=0.004786646
Epoch 214: f= 674.342, eps=0.005025978
Epoch 215: f= 674.340, eps=0.005277277
Epoch 216: f= 674.337, eps=0.005541141
Epoch 217: f= 674.335, eps=0.005818198
Epoch 218: f= 674.333, eps=0.006109108
Epoch 219: f= 674.331, eps=0.006414563
Epoch 220: f= 674.328, eps=0.006735291
Epoch 221: f= 674.326, eps=0.007072056
Epoch 222: f= 674.323, eps=0.007425659
Epoch 223: f= 674.320, eps=0.007796941
Epoch 224: f= 674.318, eps=0.008186788
Epoch 225: f= 674.315, eps=0.008596128
Epoch 226: f= 674.312, eps=0.009025934
Epoch 227: f= 674.308, eps=0.009477231
Epoch 228: f= 674.305, eps=0.009951093
Epoch 229: f= 674.302, eps=0.010448647
Epoch 230: f= 674.298, eps=0.010971080
Epoch 231: f= 674.295, eps=0.011519634
Epoch 232: f= 674.299, eps=0.005759817
Epoch 233: f= 674.306, eps=0.002879908
Epoch 234: f= 674.289, eps=0.003023904
Epoch 235: f= 674.287, eps=0.003175099
Epoch 236: f= 674.286, eps=0.003333854
Epoch 237: f= 674.285, eps=0.003500547
Epoch 238: f= 674.284, eps=0.003675574
Epoch 239: f= 674.283, eps=0.003859353
Epoch 240: f= 674.282, eps=0.004052320
Epoch 241: f= 674.281, eps=0.004254936
Epoch 242: f= 674.279, eps=0.004467683
Epoch 243: f= 674.278, eps=0.004691067

Epoch 244: f= 674.277, eps=0.004925621
Epoch 245: f= 674.275, eps=0.005171902
Epoch 246: f= 674.274, eps=0.005430497
Epoch 247: f= 674.272, eps=0.005702022
Epoch 248: f= 674.270, eps=0.005987123
Epoch 249: f= 674.269, eps=0.006286479
Epoch 250: f= 674.267, eps=0.006600803
Epoch 251: f= 674.265, eps=0.006930843
Epoch 252: f= 674.263, eps=0.007277385
Epoch 253: f= 674.261, eps=0.007641254
Epoch 254: f= 674.259, eps=0.008023317
Epoch 255: f= 674.257, eps=0.008424483
Epoch 256: f= 674.255, eps=0.008845707
Epoch 257: f= 674.258, eps=0.004422854
Epoch 258: f= 674.255, eps=0.004643996
Epoch 259: f= 674.254, eps=0.004876196
Epoch 260: f= 674.253, eps=0.005120006
Epoch 261: f= 674.253, eps=0.005376006
Epoch 262: f= 674.254, eps=0.002688003
Epoch 263: f= 674.245, eps=0.002822403
Epoch 264: f= 674.245, eps=0.002963523
Epoch 265: f= 674.244, eps=0.003111700
Epoch 266: f= 674.243, eps=0.003267285
Epoch 267: f= 674.242, eps=0.003430649
Epoch 268: f= 674.242, eps=0.003602181
Epoch 269: f= 674.241, eps=0.003782290
Epoch 270: f= 674.240, eps=0.003971405
Epoch 271: f= 674.239, eps=0.004169975
Epoch 272: f= 674.238, eps=0.004378474
Epoch 273: f= 674.237, eps=0.004597397
Epoch 274: f= 674.236, eps=0.004827267
Epoch 275: f= 674.235, eps=0.005068631
Epoch 276: f= 674.233, eps=0.005322062
Epoch 277: f= 674.232, eps=0.005588165
Epoch 278: f= 674.231, eps=0.005867574
Epoch 279: f= 674.230, eps=0.006160952
Epoch 280: f= 674.228, eps=0.006469000
Epoch 281: f= 674.227, eps=0.006792450
Epoch 282: f= 674.225, eps=0.007132072
Epoch 283: f= 674.224, eps=0.007488676
Epoch 284: f= 674.222, eps=0.007863110
Epoch 285: f= 674.220, eps=0.008256265
Epoch 286: f= 674.219, eps=0.008669078
Epoch 287: f= 674.217, eps=0.009102532
Epoch 288: f= 674.215, eps=0.009557659
Epoch 289: f= 674.213, eps=0.010035542
Epoch 290: f= 674.214, eps=0.005017771
Epoch 291: f= 674.213, eps=0.005268660

Epoch 292: f= 674.214, eps=0.002634330
Epoch 293: f= 674.208, eps=0.002766046
Epoch 294: f= 674.208, eps=0.002904349
Epoch 295: f= 674.207, eps=0.003049566
Epoch 296: f= 674.207, eps=0.003202044
Epoch 297: f= 674.206, eps=0.003362147
Epoch 298: f= 674.206, eps=0.003530254
Epoch 299: f= 674.205, eps=0.003706767
Epoch 300: f= 674.204, eps=0.003892105
Epoch 301: f= 674.203, eps=0.004086710
Epoch 302: f= 674.203, eps=0.004291046
Epoch 303: f= 674.202, eps=0.004505598
Epoch 304: f= 674.201, eps=0.004730878
Epoch 305: f= 674.200, eps=0.004967422
Epoch 306: f= 674.199, eps=0.005215793
Epoch 307: f= 674.198, eps=0.005476582
Epoch 308: f= 674.197, eps=0.005750412
Epoch 309: f= 674.196, eps=0.006037932
Epoch 310: f= 674.195, eps=0.006339829
Epoch 311: f= 674.194, eps=0.006656820
Epoch 312: f= 674.193, eps=0.006989661
Epoch 313: f= 674.192, eps=0.007339144
Epoch 314: f= 674.191, eps=0.007706101
Epoch 315: f= 674.189, eps=0.008091406
Epoch 316: f= 674.188, eps=0.008495977
Epoch 317: f= 674.187, eps=0.008920776
Epoch 318: f= 674.185, eps=0.009366814
Epoch 319: f= 674.184, eps=0.009835155
Epoch 320: f= 674.182, eps=0.010326913
Epoch 321: f= 674.182, eps=0.010843259
Epoch 322: f= 674.191, eps=0.005421629
Epoch 323: f= 674.197, eps=0.002710815
Epoch 324: f= 674.178, eps=0.002846355
Epoch 325: f= 674.177, eps=0.002988673
Epoch 326: f= 674.177, eps=0.003138107
Epoch 327: f= 674.176, eps=0.003295012
Epoch 328: f= 674.176, eps=0.003459763
Epoch 329: f= 674.175, eps=0.003632751
Epoch 330: f= 674.175, eps=0.003814388
Epoch 331: f= 674.174, eps=0.004005108
Epoch 332: f= 674.174, eps=0.004205363
Epoch 333: f= 674.173, eps=0.004415631
Epoch 334: f= 674.173, eps=0.004636413
Epoch 335: f= 674.172, eps=0.004868234
Epoch 336: f= 674.171, eps=0.005111645
Epoch 337: f= 674.171, eps=0.005367228
Epoch 338: f= 674.170, eps=0.005635589
Epoch 339: f= 674.169, eps=0.005917368

Epoch 340: f= 674.168, eps=0.006213237
Epoch 341: f= 674.167, eps=0.006523899
Epoch 342: f= 674.167, eps=0.006850094
Epoch 343: f= 674.166, eps=0.007192598
Epoch 344: f= 674.165, eps=0.007552228
Epoch 345: f= 674.164, eps=0.007929840
Epoch 346: f= 674.163, eps=0.008326332
Epoch 347: f= 674.162, eps=0.008742648
Epoch 348: f= 674.161, eps=0.009179781
Epoch 349: f= 674.160, eps=0.009638770
Epoch 350: f= 674.161, eps=0.004819385
Epoch 351: f= 674.160, eps=0.005060354
Epoch 352: f= 674.160, eps=0.005313372
Epoch 353: f= 674.161, eps=0.002656686
Epoch 354: f= 674.156, eps=0.002789520
Epoch 355: f= 674.156, eps=0.002928996
Epoch 356: f= 674.156, eps=0.003075446
Epoch 357: f= 674.155, eps=0.003229218
Epoch 358: f= 674.155, eps=0.003390679
Epoch 359: f= 674.154, eps=0.003560213
Epoch 360: f= 674.154, eps=0.003738224
Epoch 361: f= 674.154, eps=0.003925135
Epoch 362: f= 674.153, eps=0.004121392
Epoch 363: f= 674.153, eps=0.004327461
Epoch 364: f= 674.152, eps=0.004543834
Epoch 365: f= 674.152, eps=0.004771026
Epoch 366: f= 674.151, eps=0.005009577
Epoch 367: f= 674.151, eps=0.005260056
Epoch 368: f= 674.150, eps=0.005523059
Epoch 369: f= 674.150, eps=0.005799212
Epoch 370: f= 674.149, eps=0.006089173
Epoch 371: f= 674.148, eps=0.006393631
Epoch 372: f= 674.148, eps=0.006713313
Epoch 373: f= 674.147, eps=0.007048978
Epoch 374: f= 674.146, eps=0.007401427
Epoch 375: f= 674.146, eps=0.007771499
Epoch 376: f= 674.145, eps=0.008160074
Epoch 377: f= 674.144, eps=0.008568077
Epoch 378: f= 674.143, eps=0.008996481
Epoch 379: f= 674.142, eps=0.009446305
Epoch 380: f= 674.141, eps=0.009918621
Epoch 381: f= 674.141, eps=0.010414552
Epoch 382: f= 674.143, eps=0.005207276
Epoch 383: f= 674.144, eps=0.002603638
Epoch 384: f= 674.139, eps=0.002733820
Epoch 385: f= 674.138, eps=0.002870511
Epoch 386: f= 674.138, eps=0.003014036
Epoch 387: f= 674.138, eps=0.003164738

Epoch 388: f= 674.138, eps=0.003322975
Epoch 389: f= 674.137, eps=0.003489124
Epoch 390: f= 674.137, eps=0.003663580
Epoch 391: f= 674.137, eps=0.003846759
Epoch 392: f= 674.136, eps=0.004039097
Epoch 393: f= 674.136, eps=0.004241052
Epoch 394: f= 674.136, eps=0.004453104
Epoch 395: f= 674.135, eps=0.004675760
Epoch 396: f= 674.135, eps=0.004909548
Epoch 397: f= 674.135, eps=0.005155025
Epoch 398: f= 674.134, eps=0.005412776
Epoch 399: f= 674.134, eps=0.005683415
Epoch 400: f= 674.133, eps=0.005967586
Epoch 401: f= 674.133, eps=0.006265965
Epoch 402: f= 674.132, eps=0.006579263
Epoch 403: f= 674.132, eps=0.006908226
Epoch 404: f= 674.131, eps=0.007253638
Epoch 405: f= 674.131, eps=0.007616320
Epoch 406: f= 674.130, eps=0.007997136
Epoch 407: f= 674.129, eps=0.008396992
Epoch 408: f= 674.129, eps=0.008816842
Epoch 409: f= 674.128, eps=0.009257684
Epoch 410: f= 674.127, eps=0.009720568
Epoch 411: f= 674.127, eps=0.010206597
Epoch 412: f= 674.126, eps=0.010716927
Epoch 413: f= 674.127, eps=0.005358463
Epoch 414: f= 674.127, eps=0.002679232
Epoch 415: f= 674.125, eps=0.002813193
Epoch 416: f= 674.124, eps=0.002953853
Epoch 417: f= 674.124, eps=0.003101546
Epoch 418: f= 674.124, eps=0.003256623
Epoch 419: f= 674.124, eps=0.003419454
Epoch 420: f= 674.123, eps=0.003590427
Epoch 421: f= 674.123, eps=0.003769948
Epoch 422: f= 674.123, eps=0.003958445
Epoch 423: f= 674.123, eps=0.004156368
Epoch 424: f= 674.122, eps=0.004364186
Epoch 425: f= 674.122, eps=0.004582395
Epoch 426: f= 674.122, eps=0.004811515
Epoch 427: f= 674.122, eps=0.005052091
Epoch 428: f= 674.121, eps=0.005304695
Epoch 429: f= 674.121, eps=0.005569930
Epoch 430: f= 674.121, eps=0.005848427
Epoch 431: f= 674.120, eps=0.006140848
Epoch 432: f= 674.120, eps=0.006447890
Epoch 433: f= 674.119, eps=0.006770285
Epoch 434: f= 674.119, eps=0.007108799
Epoch 435: f= 674.118, eps=0.007464239

Epoch 436: f= 674.118, eps=0.007837451
Epoch 437: f= 674.118, eps=0.008229324
Epoch 438: f= 674.117, eps=0.008640790
Epoch 439: f= 674.117, eps=0.009072829
Epoch 440: f= 674.116, eps=0.009526471
Epoch 441: f= 674.116, eps=0.010002794
Epoch 442: f= 674.116, eps=0.010502934
Epoch 443: f= 674.121, eps=0.005251467
Epoch 444: f= 674.124, eps=0.002625734
Epoch 445: f= 674.114, eps=0.002757020
Epoch 446: f= 674.114, eps=0.002894871
Epoch 447: f= 674.114, eps=0.003039615
Epoch 448: f= 674.113, eps=0.003191596
Epoch 449: f= 674.113, eps=0.003351175
Epoch 450: f= 674.113, eps=0.003518734
Epoch 451: f= 674.113, eps=0.003694671
Epoch 452: f= 674.113, eps=0.003879404
Epoch 453: f= 674.113, eps=0.004073375
Epoch 454: f= 674.112, eps=0.004277043
Epoch 455: f= 674.112, eps=0.004490895
Epoch 456: f= 674.112, eps=0.004715440
Epoch 457: f= 674.112, eps=0.004951212
Epoch 458: f= 674.111, eps=0.005198773
Epoch 459: f= 674.111, eps=0.005458711
Epoch 460: f= 674.111, eps=0.005731647
Epoch 461: f= 674.111, eps=0.006018229
Epoch 462: f= 674.110, eps=0.006319141
Epoch 463: f= 674.110, eps=0.006635098
Epoch 464: f= 674.110, eps=0.006966853
Epoch 465: f= 674.109, eps=0.007315195
Epoch 466: f= 674.109, eps=0.007680955
Epoch 467: f= 674.109, eps=0.008065003
Epoch 468: f= 674.108, eps=0.008468253
Epoch 469: f= 674.108, eps=0.008891666
Epoch 470: f= 674.107, eps=0.009336249
Epoch 471: f= 674.107, eps=0.009803061
Epoch 472: f= 674.107, eps=0.010293215
Epoch 473: f= 674.107, eps=0.005146607
Epoch 474: f= 674.107, eps=0.002573304
Epoch 475: f= 674.106, eps=0.002701969
Epoch 476: f= 674.106, eps=0.002837067
Epoch 477: f= 674.106, eps=0.002978921
Epoch 478: f= 674.105, eps=0.003127867
Epoch 479: f= 674.105, eps=0.003284260
Epoch 480: f= 674.105, eps=0.003448473
Epoch 481: f= 674.105, eps=0.003620897
Epoch 482: f= 674.105, eps=0.003801941
Epoch 483: f= 674.105, eps=0.003992039

Epoch 484: f= 674.105, eps=0.004191640
 Epoch 485: f= 674.104, eps=0.004401222
 Epoch 486: f= 674.104, eps=0.004621284
 Epoch 487: f= 674.104, eps=0.004852348
 Epoch 488: f= 674.104, eps=0.005094965
 Epoch 489: f= 674.104, eps=0.005349713
 Epoch 490: f= 674.103, eps=0.005617199
 Epoch 491: f= 674.103, eps=0.005898059
 Epoch 492: f= 674.103, eps=0.006192962
 Epoch 493: f= 674.103, eps=0.006502610
 Epoch 494: f= 674.103, eps=0.006827741
 Epoch 495: f= 674.102, eps=0.007169128
 Epoch 496: f= 674.102, eps=0.007527584
 Epoch 497: f= 674.102, eps=0.007903963
 Epoch 498: f= 674.101, eps=0.008299161
 Epoch 499: f= 674.101, eps=0.008714119
 Result after 500 epochs: f=674.1008281100459
 Epoch 0: f= 6669.770, eps=0.010000000
 Epoch 1: f= 4383.683, eps=0.010500000
 Epoch 2: f= 2752.887, eps=0.011025000
 Epoch 3: f= 1974.583, eps=0.011576250
 Epoch 4: f= 1475.521, eps=0.012155063
 Epoch 5: f= 1220.853, eps=0.012762816
 Epoch 6: f= 1057.063, eps=0.013400956
 Epoch 7: f= 957.284, eps=0.014071004
 Epoch 8: f= 900.055, eps=0.014774554
 Epoch 9: f= 877.595, eps=0.015513282
 Epoch 10: f= 909.332, eps=0.007756641
 Epoch 11: f= 822.850, eps=0.008144473
 Epoch 12: f= 781.300, eps=0.008551697
 Epoch 13: f= 798.122, eps=0.004275848
 Epoch 14: f= 738.850, eps=0.004489641
 Epoch 15: f= 731.040, eps=0.004714123
 Epoch 16: f= 726.009, eps=0.004949829
 Epoch 17: f= 721.535, eps=0.005197320
 Epoch 18: f= 717.358, eps=0.005457186
 Epoch 19: f= 713.453, eps=0.005730046
 Epoch 20: f= 709.837, eps=0.006016548
 Epoch 21: f= 706.559, eps=0.006317375
 Epoch 22: f= 703.753, eps=0.006633244
 Epoch 23: f= 701.690, eps=0.006964906
 Epoch 24: f= 700.826, eps=0.007313152
 Epoch 25: f= 701.209, eps=0.003656576
 Epoch 26: f= 694.511, eps=0.003839405
 Epoch 27: f= 693.303, eps=0.004031375
 Epoch 28: f= 692.297, eps=0.004232944
 Epoch 29: f= 691.359, eps=0.004444591
 Epoch 30: f= 690.473, eps=0.004666820

Epoch	31:	f=	689.637,	eps=0.004900161
Epoch	32:	f=	688.852,	eps=0.005145169
Epoch	33:	f=	688.122,	eps=0.005402428
Epoch	34:	f=	687.450,	eps=0.005672549
Epoch	35:	f=	686.842,	eps=0.005956177
Epoch	36:	f=	686.310,	eps=0.006253986
Epoch	37:	f=	685.885,	eps=0.006566685
Epoch	38:	f=	685.676,	eps=0.006895019
Epoch	39:	f=	686.028,	eps=0.003447510
Epoch	40:	f=	684.915,	eps=0.003619885
Epoch	41:	f=	684.667,	eps=0.003800879
Epoch	42:	f=	684.504,	eps=0.003990923
Epoch	43:	f=	684.364,	eps=0.004190469
Epoch	44:	f=	684.236,	eps=0.004399993
Epoch	45:	f=	684.119,	eps=0.004619993
Epoch	46:	f=	684.011,	eps=0.004850992
Epoch	47:	f=	683.911,	eps=0.005093542
Epoch	48:	f=	683.821,	eps=0.005348219
Epoch	49:	f=	683.739,	eps=0.005615630
Epoch	50:	f=	683.666,	eps=0.005896411
Epoch	51:	f=	683.605,	eps=0.006191232
Epoch	52:	f=	683.563,	eps=0.006500794
Epoch	53:	f=	683.568,	eps=0.003250397
Epoch	54:	f=	683.465,	eps=0.003412917
Epoch	55:	f=	683.432,	eps=0.003583562
Epoch	56:	f=	683.408,	eps=0.003762741
Epoch	57:	f=	683.386,	eps=0.003950878
Epoch	58:	f=	683.365,	eps=0.004148421
Epoch	59:	f=	683.345,	eps=0.004355843
Epoch	60:	f=	683.326,	eps=0.004573635
Epoch	61:	f=	683.307,	eps=0.004802316
Epoch	62:	f=	683.290,	eps=0.005042432
Epoch	63:	f=	683.273,	eps=0.005294554
Epoch	64:	f=	683.257,	eps=0.005559282
Epoch	65:	f=	683.241,	eps=0.005837246
Epoch	66:	f=	683.227,	eps=0.006129108
Epoch	67:	f=	683.213,	eps=0.006435563
Epoch	68:	f=	683.200,	eps=0.006757341
Epoch	69:	f=	683.191,	eps=0.007095208
Epoch	70:	f=	683.191,	eps=0.003547604
Epoch	71:	f=	683.172,	eps=0.003724984
Epoch	72:	f=	683.164,	eps=0.003911234
Epoch	73:	f=	683.158,	eps=0.004106795
Epoch	74:	f=	683.152,	eps=0.004312135
Epoch	75:	f=	683.146,	eps=0.004527742
Epoch	76:	f=	683.140,	eps=0.004754129
Epoch	77:	f=	683.134,	eps=0.004991835
Epoch	78:	f=	683.128,	eps=0.005241427

Epoch 79: f= 683.122, eps=0.005503499
Epoch 80: f= 683.117, eps=0.005778674
Epoch 81: f= 683.111, eps=0.006067607
Epoch 82: f= 683.107, eps=0.006370988
Epoch 83: f= 683.105, eps=0.006689537
Epoch 84: f= 683.113, eps=0.003344768
Epoch 85: f= 683.093, eps=0.003512007
Epoch 86: f= 683.087, eps=0.003687607
Epoch 87: f= 683.084, eps=0.003871988
Epoch 88: f= 683.080, eps=0.004065587
Epoch 89: f= 683.077, eps=0.004268866
Epoch 90: f= 683.074, eps=0.004482310
Epoch 91: f= 683.070, eps=0.004706425
Epoch 92: f= 683.067, eps=0.004941746
Epoch 93: f= 683.063, eps=0.005188834
Epoch 94: f= 683.059, eps=0.005448275
Epoch 95: f= 683.056, eps=0.005720689
Epoch 96: f= 683.052, eps=0.006006724
Epoch 97: f= 683.048, eps=0.006307060
Epoch 98: f= 683.044, eps=0.006622413
Epoch 99: f= 683.042, eps=0.006953533
Epoch 100: f= 683.044, eps=0.003476767
Epoch 101: f= 683.035, eps=0.003650605
Epoch 102: f= 683.032, eps=0.003833135
Epoch 103: f= 683.029, eps=0.004024792
Epoch 104: f= 683.027, eps=0.004226032
Epoch 105: f= 683.024, eps=0.004437333
Epoch 106: f= 683.022, eps=0.004659200
Epoch 107: f= 683.019, eps=0.004892160
Epoch 108: f= 683.017, eps=0.005136768
Epoch 109: f= 683.014, eps=0.005393606
Epoch 110: f= 683.011, eps=0.005663287
Epoch 111: f= 683.009, eps=0.005946451
Epoch 112: f= 683.006, eps=0.006243773
Epoch 113: f= 683.004, eps=0.006555962
Epoch 114: f= 683.003, eps=0.006883760
Epoch 115: f= 683.008, eps=0.003441880
Epoch 116: f= 682.997, eps=0.003613974
Epoch 117: f= 682.994, eps=0.003794673
Epoch 118: f= 682.992, eps=0.003984406
Epoch 119: f= 682.990, eps=0.004183627
Epoch 120: f= 682.988, eps=0.004392808
Epoch 121: f= 682.986, eps=0.004612449
Epoch 122: f= 682.984, eps=0.004843071
Epoch 123: f= 682.982, eps=0.005085225
Epoch 124: f= 682.980, eps=0.005339486
Epoch 125: f= 682.978, eps=0.005606460
Epoch 126: f= 682.976, eps=0.005886783

Epoch 127: f= 682.974, eps=0.006181122
Epoch 128: f= 682.972, eps=0.006490178
Epoch 129: f= 682.971, eps=0.006814687
Epoch 130: f= 682.975, eps=0.003407344
Epoch 131: f= 682.967, eps=0.003577711
Epoch 132: f= 682.964, eps=0.003756596
Epoch 133: f= 682.963, eps=0.003944426
Epoch 134: f= 682.961, eps=0.004141647
Epoch 135: f= 682.960, eps=0.004348730
Epoch 136: f= 682.958, eps=0.004566166
Epoch 137: f= 682.957, eps=0.004794475
Epoch 138: f= 682.955, eps=0.005034198
Epoch 139: f= 682.954, eps=0.005285908
Epoch 140: f= 682.952, eps=0.005550204
Epoch 141: f= 682.950, eps=0.005827714
Epoch 142: f= 682.948, eps=0.006119100
Epoch 143: f= 682.947, eps=0.006425055
Epoch 144: f= 682.946, eps=0.006746307
Epoch 145: f= 682.946, eps=0.003373154
Epoch 146: f= 682.942, eps=0.003541811
Epoch 147: f= 682.941, eps=0.003718902
Epoch 148: f= 682.940, eps=0.003904847
Epoch 149: f= 682.939, eps=0.004100089
Epoch 150: f= 682.938, eps=0.004305094
Epoch 151: f= 682.936, eps=0.004520348
Epoch 152: f= 682.935, eps=0.004746366
Epoch 153: f= 682.934, eps=0.004983684
Epoch 154: f= 682.933, eps=0.005232868
Epoch 155: f= 682.931, eps=0.005494512
Epoch 156: f= 682.930, eps=0.005769237
Epoch 157: f= 682.929, eps=0.006057699
Epoch 158: f= 682.927, eps=0.006360584
Epoch 159: f= 682.926, eps=0.006678613
Epoch 160: f= 682.925, eps=0.007012544
Epoch 161: f= 682.925, eps=0.003506272
Epoch 162: f= 682.922, eps=0.003681586
Epoch 163: f= 682.921, eps=0.003865665
Epoch 164: f= 682.920, eps=0.004058948
Epoch 165: f= 682.919, eps=0.004261896
Epoch 166: f= 682.918, eps=0.004474990
Epoch 167: f= 682.917, eps=0.004698740
Epoch 168: f= 682.916, eps=0.004933677
Epoch 169: f= 682.915, eps=0.005180361
Epoch 170: f= 682.914, eps=0.005439379
Epoch 171: f= 682.913, eps=0.005711348
Epoch 172: f= 682.912, eps=0.005996915
Epoch 173: f= 682.911, eps=0.006296761
Epoch 174: f= 682.910, eps=0.006611599

Epoch 175: f= 682.910, eps=0.006942179
Epoch 176: f= 682.914, eps=0.003471089
Epoch 177: f= 682.908, eps=0.003644644
Epoch 178: f= 682.907, eps=0.003826876
Epoch 179: f= 682.906, eps=0.004018220
Epoch 180: f= 682.905, eps=0.004219131
Epoch 181: f= 682.904, eps=0.004430087
Epoch 182: f= 682.903, eps=0.004651592
Epoch 183: f= 682.903, eps=0.004884171
Epoch 184: f= 682.902, eps=0.005128380
Epoch 185: f= 682.901, eps=0.005384799
Epoch 186: f= 682.900, eps=0.005654039
Epoch 187: f= 682.899, eps=0.005936741
Epoch 188: f= 682.899, eps=0.006233578
Epoch 189: f= 682.898, eps=0.006545257
Epoch 190: f= 682.899, eps=0.003272628
Epoch 191: f= 682.896, eps=0.003436260
Epoch 192: f= 682.896, eps=0.003608073
Epoch 193: f= 682.895, eps=0.003788476
Epoch 194: f= 682.895, eps=0.003977900
Epoch 195: f= 682.894, eps=0.004176795
Epoch 196: f= 682.893, eps=0.004385635
Epoch 197: f= 682.893, eps=0.004604917
Epoch 198: f= 682.892, eps=0.004835163
Epoch 199: f= 682.892, eps=0.005076921
Epoch 200: f= 682.891, eps=0.005330767
Epoch 201: f= 682.890, eps=0.005597305
Epoch 202: f= 682.890, eps=0.005877170
Epoch 203: f= 682.889, eps=0.006171029
Epoch 204: f= 682.888, eps=0.006479580
Epoch 205: f= 682.887, eps=0.006803559
Epoch 206: f= 682.887, eps=0.007143737
Epoch 207: f= 682.887, eps=0.007500924
Epoch 208: f= 682.889, eps=0.003750462
Epoch 209: f= 682.886, eps=0.003937985
Epoch 210: f= 682.885, eps=0.004134885
Epoch 211: f= 682.884, eps=0.004341629
Epoch 212: f= 682.883, eps=0.004558710
Epoch 213: f= 682.883, eps=0.004786646
Epoch 214: f= 682.882, eps=0.005025978
Epoch 215: f= 682.882, eps=0.005277277
Epoch 216: f= 682.882, eps=0.005541141
Epoch 217: f= 682.881, eps=0.005818198
Epoch 218: f= 682.881, eps=0.002909099
Epoch 219: f= 682.880, eps=0.003054554
Epoch 220: f= 682.880, eps=0.003207282
Epoch 221: f= 682.879, eps=0.003367646
Epoch 222: f= 682.879, eps=0.003536028

Epoch 223: f= 682.879, eps=0.003712829
Epoch 224: f= 682.878, eps=0.003898471
Epoch 225: f= 682.878, eps=0.004093394
Epoch 226: f= 682.878, eps=0.004298064
Epoch 227: f= 682.877, eps=0.004512967
Epoch 228: f= 682.877, eps=0.004738616
Epoch 229: f= 682.876, eps=0.004975546
Epoch 230: f= 682.876, eps=0.005224324
Epoch 231: f= 682.876, eps=0.005485540
Epoch 232: f= 682.875, eps=0.005759817
Epoch 233: f= 682.875, eps=0.006047808
Epoch 234: f= 682.874, eps=0.006350198
Epoch 235: f= 682.874, eps=0.006667708
Epoch 236: f= 682.873, eps=0.007001093
Epoch 237: f= 682.873, eps=0.007351148
Epoch 238: f= 682.872, eps=0.007718705
Epoch 239: f= 682.872, eps=0.008104641
Epoch 240: f= 682.871, eps=0.008509873
Epoch 241: f= 682.871, eps=0.008935366
Epoch 242: f= 682.873, eps=0.004467683
Epoch 243: f= 682.872, eps=0.004691067
Epoch 244: f= 682.871, eps=0.004925621
Epoch 245: f= 682.871, eps=0.005171902
Epoch 246: f= 682.872, eps=0.002585951
Epoch 247: f= 682.869, eps=0.002715248
Epoch 248: f= 682.868, eps=0.002851011
Epoch 249: f= 682.868, eps=0.002993561
Epoch 250: f= 682.868, eps=0.003143239
Epoch 251: f= 682.868, eps=0.003300401
Epoch 252: f= 682.868, eps=0.003465421
Epoch 253: f= 682.868, eps=0.003638693
Epoch 254: f= 682.867, eps=0.003820627
Epoch 255: f= 682.867, eps=0.004011659
Epoch 256: f= 682.867, eps=0.004212241
Epoch 257: f= 682.867, eps=0.004422854
Epoch 258: f= 682.866, eps=0.004643996
Epoch 259: f= 682.866, eps=0.004876196
Epoch 260: f= 682.866, eps=0.005120006
Epoch 261: f= 682.866, eps=0.005376006
Epoch 262: f= 682.865, eps=0.005644806
Epoch 263: f= 682.865, eps=0.005927047
Epoch 264: f= 682.865, eps=0.006223399
Epoch 265: f= 682.865, eps=0.006534569
Epoch 266: f= 682.864, eps=0.006861297
Epoch 267: f= 682.864, eps=0.007204362
Epoch 268: f= 682.864, eps=0.007564580
Epoch 269: f= 682.863, eps=0.007942809
Epoch 270: f= 682.863, eps=0.008339950

Epoch 271: f= 682.863, eps=0.008756947
Epoch 272: f= 682.862, eps=0.009194795
Epoch 273: f= 682.862, eps=0.009654535
Epoch 274: f= 682.862, eps=0.010137261
Epoch 275: f= 682.861, eps=0.010644124
Epoch 276: f= 682.862, eps=0.005322062
Epoch 277: f= 682.862, eps=0.002661031
Epoch 278: f= 682.860, eps=0.002794083
Epoch 279: f= 682.860, eps=0.002933787
Epoch 280: f= 682.860, eps=0.003080476
Epoch 281: f= 682.860, eps=0.003234500
Epoch 282: f= 682.860, eps=0.003396225
Epoch 283: f= 682.860, eps=0.003566036
Epoch 284: f= 682.860, eps=0.003744338
Epoch 285: f= 682.860, eps=0.003931555
Epoch 286: f= 682.860, eps=0.004128133
Epoch 287: f= 682.859, eps=0.004334539
Epoch 288: f= 682.859, eps=0.004551266
Epoch 289: f= 682.859, eps=0.004778830
Epoch 290: f= 682.859, eps=0.005017771
Epoch 291: f= 682.859, eps=0.005268660
Epoch 292: f= 682.859, eps=0.005532093
Epoch 293: f= 682.859, eps=0.005808697
Epoch 294: f= 682.858, eps=0.006099132
Epoch 295: f= 682.858, eps=0.006404089
Epoch 296: f= 682.858, eps=0.006724293
Epoch 297: f= 682.858, eps=0.007060508
Epoch 298: f= 682.858, eps=0.007413533
Epoch 299: f= 682.857, eps=0.007784210
Epoch 300: f= 682.857, eps=0.008173420
Epoch 301: f= 682.857, eps=0.008582091
Epoch 302: f= 682.857, eps=0.009011196
Epoch 303: f= 682.857, eps=0.009461756
Epoch 304: f= 682.856, eps=0.009934843
Epoch 305: f= 682.857, eps=0.004967422
Epoch 306: f= 682.857, eps=0.005215793
Epoch 307: f= 682.857, eps=0.002607896
Epoch 308: f= 682.856, eps=0.002738291
Epoch 309: f= 682.856, eps=0.002875206
Epoch 310: f= 682.856, eps=0.003018966
Epoch 311: f= 682.856, eps=0.003169914
Epoch 312: f= 682.856, eps=0.003328410
Epoch 313: f= 682.856, eps=0.003494831
Epoch 314: f= 682.856, eps=0.003669572
Epoch 315: f= 682.855, eps=0.003853051
Epoch 316: f= 682.855, eps=0.004045703
Epoch 317: f= 682.855, eps=0.004247988
Epoch 318: f= 682.855, eps=0.004460388

Epoch 319: f= 682.855, eps=0.004683407
Epoch 320: f= 682.855, eps=0.004917578
Epoch 321: f= 682.855, eps=0.005163456
Epoch 322: f= 682.855, eps=0.005421629
Epoch 323: f= 682.855, eps=0.005692711
Epoch 324: f= 682.855, eps=0.005977346
Epoch 325: f= 682.855, eps=0.006276214
Epoch 326: f= 682.854, eps=0.006590024
Epoch 327: f= 682.854, eps=0.006919525
Epoch 328: f= 682.854, eps=0.007265502
Epoch 329: f= 682.854, eps=0.007628777
Epoch 330: f= 682.854, eps=0.008010216
Epoch 331: f= 682.854, eps=0.008410726
Epoch 332: f= 682.854, eps=0.008831263
Epoch 333: f= 682.854, eps=0.009272826
Epoch 334: f= 682.854, eps=0.009736467
Epoch 335: f= 682.853, eps=0.010223291
Epoch 336: f= 682.853, eps=0.010734455
Epoch 337: f= 682.854, eps=0.005367228
Epoch 338: f= 682.855, eps=0.002683614
Epoch 339: f= 682.853, eps=0.002817794
Epoch 340: f= 682.853, eps=0.002958684
Epoch 341: f= 682.853, eps=0.003106618
Epoch 342: f= 682.853, eps=0.003261949
Epoch 343: f= 682.853, eps=0.003425047
Epoch 344: f= 682.853, eps=0.003596299
Epoch 345: f= 682.853, eps=0.003776114
Epoch 346: f= 682.853, eps=0.003964920
Epoch 347: f= 682.853, eps=0.004163166
Epoch 348: f= 682.853, eps=0.004371324
Epoch 349: f= 682.853, eps=0.004589890
Epoch 350: f= 682.853, eps=0.004819385
Epoch 351: f= 682.853, eps=0.005060354
Epoch 352: f= 682.852, eps=0.005313372
Epoch 353: f= 682.852, eps=0.005579040
Epoch 354: f= 682.852, eps=0.005857992
Epoch 355: f= 682.852, eps=0.006150892
Epoch 356: f= 682.852, eps=0.006458437
Epoch 357: f= 682.852, eps=0.006781358
Epoch 358: f= 682.852, eps=0.007120426
Epoch 359: f= 682.852, eps=0.007476448
Epoch 360: f= 682.852, eps=0.007850270
Epoch 361: f= 682.852, eps=0.008242783
Epoch 362: f= 682.852, eps=0.008654923
Epoch 363: f= 682.852, eps=0.009087669
Epoch 364: f= 682.852, eps=0.009542052
Epoch 365: f= 682.852, eps=0.004771026
Epoch 366: f= 682.852, eps=0.005009577

Epoch 367: f= 682.852, eps=0.005260056
Epoch 368: f= 682.852, eps=0.002630028
Epoch 369: f= 682.851, eps=0.002761530
Epoch 370: f= 682.851, eps=0.002899606
Epoch 371: f= 682.851, eps=0.003044586
Epoch 372: f= 682.851, eps=0.003196816
Epoch 373: f= 682.851, eps=0.003356656
Epoch 374: f= 682.851, eps=0.003524489
Epoch 375: f= 682.851, eps=0.003700714
Epoch 376: f= 682.851, eps=0.003885749
Epoch 377: f= 682.851, eps=0.004080037
Epoch 378: f= 682.851, eps=0.004284039
Epoch 379: f= 682.851, eps=0.004498241
Epoch 380: f= 682.851, eps=0.004723153
Epoch 381: f= 682.851, eps=0.004959310
Epoch 382: f= 682.851, eps=0.005207276
Epoch 383: f= 682.851, eps=0.005467640
Epoch 384: f= 682.851, eps=0.005741022
Epoch 385: f= 682.851, eps=0.006028073
Epoch 386: f= 682.851, eps=0.006329476
Epoch 387: f= 682.851, eps=0.006645950
Epoch 388: f= 682.851, eps=0.006978248
Epoch 389: f= 682.851, eps=0.007327160
Epoch 390: f= 682.851, eps=0.007693518
Epoch 391: f= 682.851, eps=0.008078194
Epoch 392: f= 682.851, eps=0.008482104
Epoch 393: f= 682.851, eps=0.008906209
Epoch 394: f= 682.851, eps=0.009351519
Epoch 395: f= 682.851, eps=0.009819095
Epoch 396: f= 682.851, eps=0.010310050
Epoch 397: f= 682.851, eps=0.005155025
Epoch 398: f= 682.851, eps=0.002577512
Epoch 399: f= 682.850, eps=0.002706388
Epoch 400: f= 682.850, eps=0.002841708
Epoch 401: f= 682.850, eps=0.002983793
Epoch 402: f= 682.850, eps=0.003132983
Epoch 403: f= 682.850, eps=0.003289632
Epoch 404: f= 682.850, eps=0.003454113
Epoch 405: f= 682.850, eps=0.003626819
Epoch 406: f= 682.850, eps=0.003808160
Epoch 407: f= 682.850, eps=0.003998568
Epoch 408: f= 682.850, eps=0.004198496
Epoch 409: f= 682.850, eps=0.004408421
Epoch 410: f= 682.850, eps=0.004628842
Epoch 411: f= 682.850, eps=0.004860284
Epoch 412: f= 682.850, eps=0.005103298
Epoch 413: f= 682.850, eps=0.005358463
Epoch 414: f= 682.850, eps=0.005626387

Epoch 415: f= 682.850, eps=0.005907706
Epoch 416: f= 682.850, eps=0.006203091
Epoch 417: f= 682.850, eps=0.006513246
Epoch 418: f= 682.850, eps=0.006838908
Epoch 419: f= 682.850, eps=0.007180853
Epoch 420: f= 682.850, eps=0.007539896
Epoch 421: f= 682.850, eps=0.007916891
Epoch 422: f= 682.850, eps=0.008312735
Epoch 423: f= 682.850, eps=0.008728372
Epoch 424: f= 682.850, eps=0.009164791
Epoch 425: f= 682.850, eps=0.009623030
Epoch 426: f= 682.850, eps=0.010104182
Epoch 427: f= 682.850, eps=0.010609391
Epoch 428: f= 682.850, eps=0.011139860
Epoch 429: f= 682.850, eps=0.005569930
Epoch 430: f= 682.850, eps=0.002784965
Epoch 431: f= 682.850, eps=0.002924213
Epoch 432: f= 682.850, eps=0.003070424
Epoch 433: f= 682.850, eps=0.003223945
Epoch 434: f= 682.850, eps=0.003385142
Epoch 435: f= 682.850, eps=0.003554400
Epoch 436: f= 682.850, eps=0.003732120
Epoch 437: f= 682.850, eps=0.003918726
Epoch 438: f= 682.850, eps=0.004114662
Epoch 439: f= 682.850, eps=0.004320395
Epoch 440: f= 682.850, eps=0.004536415
Epoch 441: f= 682.850, eps=0.004763235
Epoch 442: f= 682.850, eps=0.005001397
Epoch 443: f= 682.850, eps=0.005251467
Epoch 444: f= 682.850, eps=0.005514040
Epoch 445: f= 682.850, eps=0.005789742
Epoch 446: f= 682.850, eps=0.006079230
Epoch 447: f= 682.850, eps=0.006383191
Epoch 448: f= 682.850, eps=0.006702351
Epoch 449: f= 682.850, eps=0.007037468
Epoch 450: f= 682.850, eps=0.007389342
Epoch 451: f= 682.850, eps=0.007758809
Epoch 452: f= 682.850, eps=0.008146749
Epoch 453: f= 682.850, eps=0.008554086
Epoch 454: f= 682.850, eps=0.008981791
Epoch 455: f= 682.850, eps=0.004490895
Epoch 456: f= 682.850, eps=0.004715440
Epoch 457: f= 682.850, eps=0.004951212
Epoch 458: f= 682.850, eps=0.002475606
Epoch 459: f= 682.850, eps=0.002599386
Epoch 460: f= 682.850, eps=0.002729356
Epoch 461: f= 682.850, eps=0.002865824
Epoch 462: f= 682.850, eps=0.003009115

Epoch 463: f= 682.850, eps=0.003159570
 Epoch 464: f= 682.850, eps=0.003317549
 Epoch 465: f= 682.850, eps=0.003483426
 Epoch 466: f= 682.850, eps=0.003657598
 Epoch 467: f= 682.850, eps=0.003840478
 Epoch 468: f= 682.850, eps=0.004032501
 Epoch 469: f= 682.850, eps=0.004234127
 Epoch 470: f= 682.850, eps=0.004445833
 Epoch 471: f= 682.849, eps=0.004668125
 Epoch 472: f= 682.849, eps=0.004901531
 Epoch 473: f= 682.849, eps=0.005146607
 Epoch 474: f= 682.849, eps=0.005403938
 Epoch 475: f= 682.849, eps=0.005674135
 Epoch 476: f= 682.849, eps=0.005957841
 Epoch 477: f= 682.849, eps=0.006255733
 Epoch 478: f= 682.849, eps=0.006568520
 Epoch 479: f= 682.849, eps=0.006896946
 Epoch 480: f= 682.849, eps=0.007241793
 Epoch 481: f= 682.849, eps=0.007603883
 Epoch 482: f= 682.849, eps=0.007984077
 Epoch 483: f= 682.849, eps=0.008383281
 Epoch 484: f= 682.849, eps=0.008802445
 Epoch 485: f= 682.849, eps=0.009242567
 Epoch 486: f= 682.849, eps=0.009704696
 Epoch 487: f= 682.849, eps=0.010189930
 Epoch 488: f= 682.849, eps=0.010699427
 Epoch 489: f= 682.849, eps=0.011234398
 Epoch 490: f= 682.849, eps=0.011796118
 Epoch 491: f= 682.849, eps=0.005898059
 Epoch 492: f= 682.849, eps=0.002949030
 Epoch 493: f= 682.849, eps=0.003096481
 Epoch 494: f= 682.849, eps=0.003251305
 Epoch 495: f= 682.849, eps=0.003413870
 Epoch 496: f= 682.849, eps=0.003584564
 Epoch 497: f= 682.849, eps=0.003763792
 Epoch 498: f= 682.849, eps=0.003951982
 Epoch 499: f= 682.849, eps=0.004149581
 Result after 500 epochs: f=682.8492956819674
 Epoch 0: f= 6703.331, eps=0.010000000
 Epoch 1: f= 4550.363, eps=0.010500000
 Epoch 2: f= 2842.373, eps=0.011025000
 Epoch 3: f= 2014.048, eps=0.011576250
 Epoch 4: f= 1492.397, eps=0.012155063
 Epoch 5: f= 1224.571, eps=0.012762816
 Epoch 6: f= 1053.240, eps=0.013400956
 Epoch 7: f= 950.429, eps=0.014071004
 Epoch 8: f= 906.709, eps=0.014774554
 Epoch 9: f= 952.738, eps=0.007387277

Epoch	10:	f=	831.529,	eps=0.007756641
Epoch	11:	f=	818.434,	eps=0.008144473
Epoch	12:	f=	849.404,	eps=0.004072237
Epoch	13:	f=	763.185,	eps=0.004275848
Epoch	14:	f=	747.639,	eps=0.004489641
Epoch	15:	f=	740.861,	eps=0.004714123
Epoch	16:	f=	735.408,	eps=0.004949829
Epoch	17:	f=	730.460,	eps=0.005197320
Epoch	18:	f=	725.921,	eps=0.005457186
Epoch	19:	f=	721.765,	eps=0.005730046
Epoch	20:	f=	717.996,	eps=0.006016548
Epoch	21:	f=	714.616,	eps=0.006317375
Epoch	22:	f=	711.667,	eps=0.006633244
Epoch	23:	f=	709.262,	eps=0.006964906
Epoch	24:	f=	707.968,	eps=0.007313152
Epoch	25:	f=	709.731,	eps=0.003656576
Epoch	26:	f=	704.608,	eps=0.003839405
Epoch	27:	f=	702.999,	eps=0.004031375
Epoch	28:	f=	702.066,	eps=0.004232944
Epoch	29:	f=	701.292,	eps=0.004444591
Epoch	30:	f=	700.608,	eps=0.004666820
Epoch	31:	f=	699.990,	eps=0.004900161
Epoch	32:	f=	699.436,	eps=0.005145169
Epoch	33:	f=	698.945,	eps=0.005402428
Epoch	34:	f=	698.525,	eps=0.005672549
Epoch	35:	f=	698.197,	eps=0.005956177
Epoch	36:	f=	698.033,	eps=0.006253986
Epoch	37:	f=	698.241,	eps=0.003126993
Epoch	38:	f=	697.356,	eps=0.003283342
Epoch	39:	f=	697.172,	eps=0.003447510
Epoch	40:	f=	697.051,	eps=0.003619885
Epoch	41:	f=	696.944,	eps=0.003800879
Epoch	42:	f=	696.844,	eps=0.003990923
Epoch	43:	f=	696.751,	eps=0.004190469
Epoch	44:	f=	696.665,	eps=0.004399993
Epoch	45:	f=	696.586,	eps=0.004619993
Epoch	46:	f=	696.512,	eps=0.004850992
Epoch	47:	f=	696.444,	eps=0.005093542
Epoch	48:	f=	696.381,	eps=0.005348219
Epoch	49:	f=	696.324,	eps=0.005615630
Epoch	50:	f=	696.271,	eps=0.005896411
Epoch	51:	f=	696.222,	eps=0.006191232
Epoch	52:	f=	696.178,	eps=0.006500794
Epoch	53:	f=	696.138,	eps=0.006825833
Epoch	54:	f=	696.106,	eps=0.007167125
Epoch	55:	f=	696.101,	eps=0.007525481
Epoch	56:	f=	696.224,	eps=0.003762741
Epoch	57:	f=	696.076,	eps=0.003950878

Epoch 58: f= 696.023, eps=0.004148421
 Epoch 59: f= 695.995, eps=0.004355843
 Epoch 60: f= 695.974, eps=0.004573635
 Epoch 61: f= 695.957, eps=0.004802316
 Epoch 62: f= 695.942, eps=0.005042432
 Epoch 63: f= 695.929, eps=0.005294554
 Epoch 64: f= 695.921, eps=0.005559282
 Epoch 65: f= 695.924, eps=0.002779641
 Epoch 66: f= 695.877, eps=0.002918623
 Epoch 67: f= 695.868, eps=0.003064554
 Epoch 68: f= 695.860, eps=0.003217782
 Epoch 69: f= 695.852, eps=0.003378671
 Epoch 70: f= 695.843, eps=0.003547604
 Epoch 71: f= 695.835, eps=0.003724984
 Epoch 72: f= 695.826, eps=0.003911234
 Epoch 73: f= 695.817, eps=0.004106795
 Epoch 74: f= 695.808, eps=0.004312135
 Epoch 75: f= 695.799, eps=0.004527742
 Epoch 76: f= 695.789, eps=0.004754129
 Epoch 77: f= 695.779, eps=0.004991835
 Epoch 78: f= 695.769, eps=0.005241427
 Epoch 79: f= 695.759, eps=0.005503499
 Epoch 80: f= 695.749, eps=0.005778674
 Epoch 81: f= 695.739, eps=0.006067607
 Epoch 82: f= 695.728, eps=0.006370988
 Epoch 83: f= 695.718, eps=0.006689537
 Epoch 84: f= 695.707, eps=0.007024014
 Epoch 85: f= 695.696, eps=0.007375214
 Epoch 86: f= 695.685, eps=0.007743975
 Epoch 87: f= 695.674, eps=0.008131174
 Epoch 88: f= 695.663, eps=0.008537733
 Epoch 89: f= 695.652, eps=0.008964619
 Epoch 90: f= 695.650, eps=0.009412850
 Epoch 91: f= 695.721, eps=0.004706425
 Epoch 92: f= 695.713, eps=0.004941746
 Epoch 93: f= 695.723, eps=0.002470873
 Epoch 94: f= 695.615, eps=0.002594417
 Epoch 95: f= 695.612, eps=0.002724138
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Epoch 475: f= 695.400, eps=0.005674135
Epoch 476: f= 695.400, eps=0.005957841
Epoch 477: f= 695.400, eps=0.006255733
Epoch 478: f= 695.400, eps=0.006568520
Epoch 479: f= 695.400, eps=0.006896946
Epoch 480: f= 695.400, eps=0.007241793
Epoch 481: f= 695.400, eps=0.007603883
Epoch 482: f= 695.400, eps=0.007984077
Epoch 483: f= 695.400, eps=0.008383281
Epoch 484: f= 695.400, eps=0.008802445
Epoch 485: f= 695.400, eps=0.009242567
Epoch 486: f= 695.400, eps=0.009704696
Epoch 487: f= 695.400, eps=0.010189930
Epoch 488: f= 695.400, eps=0.005094965
Epoch 489: f= 695.400, eps=0.002547483

Epoch 490: f= 695.400, eps=0.002674857
 Epoch 491: f= 695.400, eps=0.002808600
 Epoch 492: f= 695.400, eps=0.002949030
 Epoch 493: f= 695.400, eps=0.003096481
 Epoch 494: f= 695.400, eps=0.003251305
 Epoch 495: f= 695.400, eps=0.003413870
 Epoch 496: f= 695.400, eps=0.003584564
 Epoch 497: f= 695.400, eps=0.003763792
 Epoch 498: f= 695.400, eps=0.003951982
 Epoch 499: f= 695.400, eps=0.004149581
 Result after 500 epochs: f=695.3995518029757
 Epoch 0: f= 6736.893, eps=0.010000000
 Epoch 1: f= 4717.013, eps=0.010500000
 Epoch 2: f= 2926.106, eps=0.011025000
 Epoch 3: f= 2045.068, eps=0.011576250
 Epoch 4: f= 1501.277, eps=0.012155063
 Epoch 5: f= 1220.344, eps=0.012762816
 Epoch 6: f= 1043.506, eps=0.013400956
 Epoch 7: f= 942.603, eps=0.014071004
 Epoch 8: f= 936.434, eps=0.014774554
 Epoch 9: f= 1212.410, eps=0.007387277
 Epoch 10: f= 868.406, eps=0.007756641
 Epoch 11: f= 838.963, eps=0.008144473
 Epoch 12: f= 906.272, eps=0.004072237
 Epoch 13: f= 775.845, eps=0.004275848
 Epoch 14: f= 749.536, eps=0.004489641
 Epoch 15: f= 741.223, eps=0.004714123
 Epoch 16: f= 735.865, eps=0.004949829
 Epoch 17: f= 731.367, eps=0.005197320
 Epoch 18: f= 727.447, eps=0.005457186
 Epoch 19: f= 724.017, eps=0.005730046
 Epoch 20: f= 721.118, eps=0.006016548
 Epoch 21: f= 718.839, eps=0.006317375
 Epoch 22: f= 717.703, eps=0.006633244
 Epoch 23: f= 719.040, eps=0.003316622
 Epoch 24: f= 713.642, eps=0.003482453
 Epoch 25: f= 712.405, eps=0.003656576
 Epoch 26: f= 711.627, eps=0.003839405
 Epoch 27: f= 710.958, eps=0.004031375
 Epoch 28: f= 710.354, eps=0.004232944
 Epoch 29: f= 709.806, eps=0.004444591
 Epoch 30: f= 709.312, eps=0.004666820
 Epoch 31: f= 708.870, eps=0.004900161
 Epoch 32: f= 708.477, eps=0.005145169
 Epoch 33: f= 708.132, eps=0.005402428
 Epoch 34: f= 707.832, eps=0.005672549
 Epoch 35: f= 707.575, eps=0.005956177
 Epoch 36: f= 707.366, eps=0.006253986

Epoch	37:	f=	707.225,	eps=0.006566685
Epoch	38:	f=	707.248,	eps=0.003283342
Epoch	39:	f=	706.948,	eps=0.003447510
Epoch	40:	f=	706.847,	eps=0.003619885
Epoch	41:	f=	706.776,	eps=0.003800879
Epoch	42:	f=	706.714,	eps=0.003990923
Epoch	43:	f=	706.655,	eps=0.004190469
Epoch	44:	f=	706.599,	eps=0.004399993
Epoch	45:	f=	706.546,	eps=0.004619993
Epoch	46:	f=	706.496,	eps=0.004850992
Epoch	47:	f=	706.448,	eps=0.005093542
Epoch	48:	f=	706.402,	eps=0.005348219
Epoch	49:	f=	706.359,	eps=0.005615630
Epoch	50:	f=	706.317,	eps=0.005896411
Epoch	51:	f=	706.279,	eps=0.006191232
Epoch	52:	f=	706.247,	eps=0.006500794
Epoch	53:	f=	706.234,	eps=0.006825833
Epoch	54:	f=	706.297,	eps=0.003412917
Epoch	55:	f=	706.174,	eps=0.003583562
Epoch	56:	f=	706.136,	eps=0.003762741
Epoch	57:	f=	706.113,	eps=0.003950878
Epoch	58:	f=	706.094,	eps=0.004148421
Epoch	59:	f=	706.076,	eps=0.004355843
Epoch	60:	f=	706.057,	eps=0.004573635
Epoch	61:	f=	706.039,	eps=0.004802316
Epoch	62:	f=	706.021,	eps=0.005042432
Epoch	63:	f=	706.003,	eps=0.005294554
Epoch	64:	f=	705.985,	eps=0.005559282
Epoch	65:	f=	705.969,	eps=0.005837246
Epoch	66:	f=	705.955,	eps=0.006129108
Epoch	67:	f=	705.950,	eps=0.006435563
Epoch	68:	f=	705.979,	eps=0.003217782
Epoch	69:	f=	705.911,	eps=0.003378671
Epoch	70:	f=	705.893,	eps=0.003547604
Epoch	71:	f=	705.883,	eps=0.003724984
Epoch	72:	f=	705.873,	eps=0.003911234
Epoch	73:	f=	705.863,	eps=0.004106795
Epoch	74:	f=	705.853,	eps=0.004312135
Epoch	75:	f=	705.843,	eps=0.004527742
Epoch	76:	f=	705.833,	eps=0.004754129
Epoch	77:	f=	705.822,	eps=0.004991835
Epoch	78:	f=	705.812,	eps=0.005241427
Epoch	79:	f=	705.801,	eps=0.005503499
Epoch	80:	f=	705.791,	eps=0.005778674
Epoch	81:	f=	705.780,	eps=0.006067607
Epoch	82:	f=	705.770,	eps=0.006370988
Epoch	83:	f=	705.761,	eps=0.006689537
Epoch	84:	f=	705.758,	eps=0.007024014

Epoch 85: f= 705.780, eps=0.003512007
Epoch 86: f= 705.743, eps=0.003687607
Epoch 87: f= 705.730, eps=0.003871988
Epoch 88: f= 705.722, eps=0.004065587
Epoch 89: f= 705.716, eps=0.004268866
Epoch 90: f= 705.710, eps=0.004482310
Epoch 91: f= 705.704, eps=0.004706425
Epoch 92: f= 705.698, eps=0.004941746
Epoch 93: f= 705.692, eps=0.005188834
Epoch 94: f= 705.687, eps=0.005448275
Epoch 95: f= 705.682, eps=0.005720689
Epoch 96: f= 705.678, eps=0.006006724
Epoch 97: f= 705.679, eps=0.003003362
Epoch 98: f= 705.665, eps=0.003153530
Epoch 99: f= 705.661, eps=0.003311206
Epoch 100: f= 705.658, eps=0.003476767
Epoch 101: f= 705.655, eps=0.003650605
Epoch 102: f= 705.651, eps=0.003833135
Epoch 103: f= 705.648, eps=0.004024792
Epoch 104: f= 705.645, eps=0.004226032
Epoch 105: f= 705.641, eps=0.004437333
Epoch 106: f= 705.637, eps=0.004659200
Epoch 107: f= 705.634, eps=0.004892160
Epoch 108: f= 705.630, eps=0.005136768
Epoch 109: f= 705.626, eps=0.005393606
Epoch 110: f= 705.623, eps=0.005663287
Epoch 111: f= 705.619, eps=0.005946451
Epoch 112: f= 705.615, eps=0.006243773
Epoch 113: f= 705.611, eps=0.006555962
Epoch 114: f= 705.607, eps=0.006883760
Epoch 115: f= 705.604, eps=0.007227948
Epoch 116: f= 705.600, eps=0.007589346
Epoch 117: f= 705.599, eps=0.007968813
Epoch 118: f= 705.613, eps=0.003984406
Epoch 119: f= 705.601, eps=0.004183627
Epoch 120: f= 705.595, eps=0.004392808
Epoch 121: f= 705.592, eps=0.004612449
Epoch 122: f= 705.590, eps=0.004843071
Epoch 123: f= 705.589, eps=0.005085225
Epoch 124: f= 705.589, eps=0.002542612
Epoch 125: f= 705.580, eps=0.002669743
Epoch 126: f= 705.579, eps=0.002803230
Epoch 127: f= 705.578, eps=0.002943392
Epoch 128: f= 705.577, eps=0.003090561
Epoch 129: f= 705.576, eps=0.003245089
Epoch 130: f= 705.574, eps=0.003407344
Epoch 131: f= 705.573, eps=0.003577711
Epoch 132: f= 705.572, eps=0.003756596

Epoch 133: f= 705.571, eps=0.003944426
Epoch 134: f= 705.570, eps=0.004141647
Epoch 135: f= 705.569, eps=0.004348730
Epoch 136: f= 705.567, eps=0.004566166
Epoch 137: f= 705.566, eps=0.004794475
Epoch 138: f= 705.565, eps=0.005034198
Epoch 139: f= 705.563, eps=0.005285908
Epoch 140: f= 705.562, eps=0.005550204
Epoch 141: f= 705.561, eps=0.005827714
Epoch 142: f= 705.559, eps=0.006119100
Epoch 143: f= 705.558, eps=0.006425055
Epoch 144: f= 705.557, eps=0.006746307
Epoch 145: f= 705.555, eps=0.007083623
Epoch 146: f= 705.554, eps=0.007437804
Epoch 147: f= 705.553, eps=0.007809694
Epoch 148: f= 705.551, eps=0.008200179
Epoch 149: f= 705.550, eps=0.008610188
Epoch 150: f= 705.549, eps=0.009040697
Epoch 151: f= 705.547, eps=0.009492732
Epoch 152: f= 705.546, eps=0.009967368
Epoch 153: f= 705.546, eps=0.010465737
Epoch 154: f= 705.553, eps=0.005232868
Epoch 155: f= 705.557, eps=0.002616434
Epoch 156: f= 705.543, eps=0.002747256
Epoch 157: f= 705.542, eps=0.002884619
Epoch 158: f= 705.542, eps=0.003028850
Epoch 159: f= 705.542, eps=0.003180292
Epoch 160: f= 705.542, eps=0.003339307
Epoch 161: f= 705.541, eps=0.003506272
Epoch 162: f= 705.541, eps=0.003681586
Epoch 163: f= 705.541, eps=0.003865665
Epoch 164: f= 705.540, eps=0.004058948
Epoch 165: f= 705.540, eps=0.004261896
Epoch 166: f= 705.540, eps=0.004474990
Epoch 167: f= 705.539, eps=0.004698740
Epoch 168: f= 705.539, eps=0.004933677
Epoch 169: f= 705.538, eps=0.005180361
Epoch 170: f= 705.538, eps=0.005439379
Epoch 171: f= 705.538, eps=0.005711348
Epoch 172: f= 705.537, eps=0.005996915
Epoch 173: f= 705.537, eps=0.006296761
Epoch 174: f= 705.537, eps=0.006611599
Epoch 175: f= 705.536, eps=0.006942179
Epoch 176: f= 705.536, eps=0.007289288
Epoch 177: f= 705.535, eps=0.007653752
Epoch 178: f= 705.535, eps=0.008036440
Epoch 179: f= 705.535, eps=0.008438262
Epoch 180: f= 705.534, eps=0.008860175

Epoch 181: f= 705.534, eps=0.009303184
Epoch 182: f= 705.534, eps=0.004651592
Epoch 183: f= 705.534, eps=0.004884171
Epoch 184: f= 705.534, eps=0.002442086
Epoch 185: f= 705.533, eps=0.002564190
Epoch 186: f= 705.533, eps=0.002692399
Epoch 187: f= 705.533, eps=0.002827019
Epoch 188: f= 705.533, eps=0.002968370
Epoch 189: f= 705.533, eps=0.003116789
Epoch 190: f= 705.533, eps=0.003272628
Epoch 191: f= 705.533, eps=0.003436260
Epoch 192: f= 705.532, eps=0.003608073
Epoch 193: f= 705.532, eps=0.003788476
Epoch 194: f= 705.532, eps=0.003977900
Epoch 195: f= 705.532, eps=0.004176795
Epoch 196: f= 705.532, eps=0.004385635
Epoch 197: f= 705.532, eps=0.004604917
Epoch 198: f= 705.532, eps=0.004835163
Epoch 199: f= 705.532, eps=0.005076921
Epoch 200: f= 705.532, eps=0.005330767
Epoch 201: f= 705.531, eps=0.005597305
Epoch 202: f= 705.531, eps=0.005877170
Epoch 203: f= 705.531, eps=0.006171029
Epoch 204: f= 705.531, eps=0.006479580
Epoch 205: f= 705.531, eps=0.006803559
Epoch 206: f= 705.531, eps=0.007143737
Epoch 207: f= 705.531, eps=0.007500924
Epoch 208: f= 705.531, eps=0.007875970
Epoch 209: f= 705.530, eps=0.008269769
Epoch 210: f= 705.530, eps=0.008683257
Epoch 211: f= 705.530, eps=0.009117420
Epoch 212: f= 705.530, eps=0.009573291
Epoch 213: f= 705.530, eps=0.010051956
Epoch 214: f= 705.530, eps=0.010554554
Epoch 215: f= 705.530, eps=0.011082281
Epoch 216: f= 705.530, eps=0.005541141
Epoch 217: f= 705.530, eps=0.002770570
Epoch 218: f= 705.530, eps=0.002909099
Epoch 219: f= 705.530, eps=0.003054554
Epoch 220: f= 705.529, eps=0.003207282
Epoch 221: f= 705.529, eps=0.003367646
Epoch 222: f= 705.529, eps=0.003536028
Epoch 223: f= 705.529, eps=0.003712829
Epoch 224: f= 705.529, eps=0.003898471
Epoch 225: f= 705.529, eps=0.004093394
Epoch 226: f= 705.529, eps=0.004298064
Epoch 227: f= 705.529, eps=0.004512967
Epoch 228: f= 705.529, eps=0.004738616

Epoch 229: f= 705.529, eps=0.004975546
Epoch 230: f= 705.529, eps=0.005224324
Epoch 231: f= 705.529, eps=0.005485540
Epoch 232: f= 705.529, eps=0.005759817
Epoch 233: f= 705.529, eps=0.006047808
Epoch 234: f= 705.529, eps=0.006350198
Epoch 235: f= 705.529, eps=0.006667708
Epoch 236: f= 705.529, eps=0.007001093
Epoch 237: f= 705.529, eps=0.007351148
Epoch 238: f= 705.529, eps=0.007718705
Epoch 239: f= 705.529, eps=0.008104641
Epoch 240: f= 705.529, eps=0.008509873
Epoch 241: f= 705.529, eps=0.004254936
Epoch 242: f= 705.529, eps=0.004467683
Epoch 243: f= 705.529, eps=0.004691067
Epoch 244: f= 705.529, eps=0.004925621
Epoch 245: f= 705.529, eps=0.005171902
Epoch 246: f= 705.529, eps=0.005430497
Epoch 247: f= 705.529, eps=0.002715248
Epoch 248: f= 705.529, eps=0.002851011
Epoch 249: f= 705.529, eps=0.002993561
Epoch 250: f= 705.529, eps=0.003143239
Epoch 251: f= 705.529, eps=0.003300401
Epoch 252: f= 705.529, eps=0.003465421
Epoch 253: f= 705.529, eps=0.003638693
Epoch 254: f= 705.529, eps=0.003820627
Epoch 255: f= 705.529, eps=0.004011659
Epoch 256: f= 705.529, eps=0.004212241
Epoch 257: f= 705.529, eps=0.004422854
Epoch 258: f= 705.529, eps=0.004643996
Epoch 259: f= 705.529, eps=0.004876196
Epoch 260: f= 705.529, eps=0.005120006
Epoch 261: f= 705.529, eps=0.005376006
Epoch 262: f= 705.529, eps=0.005644806
Epoch 263: f= 705.529, eps=0.005927047
Epoch 264: f= 705.529, eps=0.006223399
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Epoch 267: f= 705.529, eps=0.007204362
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Epoch 269: f= 705.529, eps=0.007942809
Epoch 270: f= 705.529, eps=0.008339950
Epoch 271: f= 705.529, eps=0.008756947
Epoch 272: f= 705.529, eps=0.009194795
Epoch 273: f= 705.529, eps=0.004597397
Epoch 274: f= 705.529, eps=0.004827267
Epoch 275: f= 705.529, eps=0.002413634
Epoch 276: f= 705.529, eps=0.002534315

Epoch 277: f= 705.529, eps=0.002661031
Epoch 278: f= 705.529, eps=0.002794083
Epoch 279: f= 705.528, eps=0.002933787
Epoch 280: f= 705.528, eps=0.003080476
Epoch 281: f= 705.528, eps=0.003234500
Epoch 282: f= 705.528, eps=0.003396225
Epoch 283: f= 705.528, eps=0.003566036
Epoch 284: f= 705.528, eps=0.003744338
Epoch 285: f= 705.528, eps=0.003931555
Epoch 286: f= 705.528, eps=0.004128133
Epoch 287: f= 705.528, eps=0.004334539
Epoch 288: f= 705.528, eps=0.004551266
Epoch 289: f= 705.528, eps=0.004778830
Epoch 290: f= 705.528, eps=0.005017771
Epoch 291: f= 705.528, eps=0.005268660
Epoch 292: f= 705.528, eps=0.005532093
Epoch 293: f= 705.528, eps=0.005808697
Epoch 294: f= 705.528, eps=0.006099132
Epoch 295: f= 705.528, eps=0.006404089
Epoch 296: f= 705.528, eps=0.006724293
Epoch 297: f= 705.528, eps=0.007060508
Epoch 298: f= 705.528, eps=0.007413533
Epoch 299: f= 705.528, eps=0.007784210
Epoch 300: f= 705.528, eps=0.008173420
Epoch 301: f= 705.528, eps=0.008582091
Epoch 302: f= 705.528, eps=0.009011196
Epoch 303: f= 705.528, eps=0.009461756
Epoch 304: f= 705.528, eps=0.009934843
Epoch 305: f= 705.528, eps=0.010431585
Epoch 306: f= 705.528, eps=0.010953165
Epoch 307: f= 705.528, eps=0.011500823
Epoch 308: f= 705.528, eps=0.005750412
Epoch 309: f= 705.528, eps=0.002875206
Epoch 310: f= 705.528, eps=0.003018966
Epoch 311: f= 705.528, eps=0.003169914
Epoch 312: f= 705.528, eps=0.003328410
Epoch 313: f= 705.528, eps=0.003494831
Epoch 314: f= 705.528, eps=0.003669572
Epoch 315: f= 705.528, eps=0.003853051
Epoch 316: f= 705.528, eps=0.004045703
Epoch 317: f= 705.528, eps=0.004247988
Epoch 318: f= 705.528, eps=0.004460388
Epoch 319: f= 705.528, eps=0.004683407
Epoch 320: f= 705.528, eps=0.004917578
Epoch 321: f= 705.528, eps=0.005163456
Epoch 322: f= 705.528, eps=0.005421629
Epoch 323: f= 705.528, eps=0.005692711
Epoch 324: f= 705.528, eps=0.005977346

Epoch 325: f= 705.528, eps=0.006276214
Epoch 326: f= 705.528, eps=0.006590024
Epoch 327: f= 705.528, eps=0.006919525
Epoch 328: f= 705.528, eps=0.007265502
Epoch 329: f= 705.528, eps=0.007628777
Epoch 330: f= 705.528, eps=0.008010216
Epoch 331: f= 705.528, eps=0.004005108
Epoch 332: f= 705.528, eps=0.004205363
Epoch 333: f= 705.528, eps=0.004415631
Epoch 334: f= 705.528, eps=0.004636413
Epoch 335: f= 705.528, eps=0.004868234
Epoch 336: f= 705.528, eps=0.005111645
Epoch 337: f= 705.528, eps=0.002555823
Epoch 338: f= 705.528, eps=0.002683614
Epoch 339: f= 705.528, eps=0.002817794
Epoch 340: f= 705.528, eps=0.002958684
Epoch 341: f= 705.528, eps=0.003106618
Epoch 342: f= 705.528, eps=0.003261949
Epoch 343: f= 705.528, eps=0.003425047
Epoch 344: f= 705.528, eps=0.003596299
Epoch 345: f= 705.528, eps=0.003776114
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Epoch 348: f= 705.528, eps=0.004371324
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Epoch 359: f= 705.528, eps=0.007476448
Epoch 360: f= 705.528, eps=0.007850270
Epoch 361: f= 705.528, eps=0.008242783
Epoch 362: f= 705.528, eps=0.008654923
Epoch 363: f= 705.528, eps=0.009087669
Epoch 364: f= 705.528, eps=0.009542052
Epoch 365: f= 705.528, eps=0.010019155
Epoch 366: f= 705.528, eps=0.005009577
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Epoch 462: f= 705.528, eps=0.003009115
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Epoch 465: f= 705.528, eps=0.003483426
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Epoch 468: f= 705.528, eps=0.004032501

Epoch 469: f= 705.528, eps=0.004234127
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 Epoch 486: f= 705.528, eps=0.009704696
 Epoch 487: f= 705.528, eps=0.0101852348
 Epoch 488: f= 705.528, eps=0.0106826174
 Epoch 489: f= 705.528, eps=0.0111954783
 Epoch 490: f= 705.528, eps=0.011724857
 Epoch 491: f= 705.528, eps=0.0122708600
 Epoch 492: f= 705.528, eps=0.0128349030
 Epoch 493: f= 705.528, eps=0.013416481
 Epoch 494: f= 705.528, eps=0.0140151305
 Epoch 495: f= 705.528, eps=0.0146313870
 Epoch 496: f= 705.528, eps=0.015264564
 Epoch 497: f= 705.528, eps=0.015915792
 Epoch 498: f= 705.528, eps=0.0165841982
 Epoch 499: f= 705.528, eps=0.017269581
 Result after 500 epochs: f=705.5283790137129
 Epoch 0: f= 6770.454, eps=0.010000000
 Epoch 1: f= 4883.652, eps=0.010500000
 Epoch 2: f= 3004.218, eps=0.011025000
 Epoch 3: f= 2068.167, eps=0.011576250
 Epoch 4: f= 1503.254, eps=0.012155063
 Epoch 5: f= 1210.041, eps=0.012762816
 Epoch 6: f= 1030.827, eps=0.013400956
 Epoch 7: f= 940.218, eps=0.014071004
 Epoch 8: f= 1012.452, eps=0.007035502
 Epoch 9: f= 991.542, eps=0.007387277
 Epoch 10: f= 882.766, eps=0.007756641
 Epoch 11: f= 936.365, eps=0.003878321
 Epoch 12: f= 774.532, eps=0.004072237
 Epoch 13: f= 762.350, eps=0.004275848
 Epoch 14: f= 754.957, eps=0.004489641
 Epoch 15: f= 748.766, eps=0.004714123

Epoch 16: f= 743.375, eps=0.004949829
Epoch 17: f= 738.647, eps=0.005197320
Epoch 18: f= 734.513, eps=0.005457186
Epoch 19: f= 730.931, eps=0.005730046
Epoch 20: f= 727.865, eps=0.006016548
Epoch 21: f= 725.286, eps=0.006317375
Epoch 22: f= 723.184, eps=0.006633244
Epoch 23: f= 721.640, eps=0.006964906
Epoch 24: f= 721.108, eps=0.007313152
Epoch 25: f= 723.326, eps=0.003656576
Epoch 26: f= 719.090, eps=0.003839405
Epoch 27: f= 718.197, eps=0.004031375
Epoch 28: f= 717.685, eps=0.004232944
Epoch 29: f= 717.300, eps=0.004444591
Epoch 30: f= 716.990, eps=0.004666820
Epoch 31: f= 716.734, eps=0.004900161
Epoch 32: f= 716.532, eps=0.005145169
Epoch 33: f= 716.399, eps=0.005402428
Epoch 34: f= 716.388, eps=0.005672549
Epoch 35: f= 716.647, eps=0.002836275
Epoch 36: f= 715.836, eps=0.002978088
Epoch 37: f= 715.732, eps=0.003126993
Epoch 38: f= 715.666, eps=0.003283342
Epoch 39: f= 715.605, eps=0.003447510
Epoch 40: f= 715.546, eps=0.003619885
Epoch 41: f= 715.489, eps=0.003800879
Epoch 42: f= 715.434, eps=0.003990923
Epoch 43: f= 715.381, eps=0.004190469
Epoch 44: f= 715.330, eps=0.004399993
Epoch 45: f= 715.281, eps=0.004619993
Epoch 46: f= 715.234, eps=0.004850992
Epoch 47: f= 715.188, eps=0.005093542
Epoch 48: f= 715.143, eps=0.005348219
Epoch 49: f= 715.100, eps=0.005615630
Epoch 50: f= 715.058, eps=0.005896411
Epoch 51: f= 715.017, eps=0.006191232
Epoch 52: f= 714.978, eps=0.006500794
Epoch 53: f= 714.940, eps=0.006825833
Epoch 54: f= 714.903, eps=0.007167125
Epoch 55: f= 714.871, eps=0.007525481
Epoch 56: f= 714.856, eps=0.007901755
Epoch 57: f= 714.948, eps=0.003950878
Epoch 58: f= 714.863, eps=0.004148421
Epoch 59: f= 714.820, eps=0.004355843
Epoch 60: f= 714.795, eps=0.004573635
Epoch 61: f= 714.780, eps=0.004802316
Epoch 62: f= 714.775, eps=0.005042432
Epoch 63: f= 714.785, eps=0.002521216

Epoch 64: f= 714.695, eps=0.002647277
Epoch 65: f= 714.686, eps=0.002779641
Epoch 66: f= 714.678, eps=0.002918623
Epoch 67: f= 714.670, eps=0.003064554
Epoch 68: f= 714.662, eps=0.003217782
Epoch 69: f= 714.653, eps=0.003378671
Epoch 70: f= 714.645, eps=0.003547604
Epoch 71: f= 714.636, eps=0.003724984
Epoch 72: f= 714.627, eps=0.003911234
Epoch 73: f= 714.618, eps=0.004106795
Epoch 74: f= 714.609, eps=0.004312135
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Epoch 77: f= 714.581, eps=0.004991835
Epoch 78: f= 714.571, eps=0.005241427
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Epoch 80: f= 714.553, eps=0.005778674
Epoch 81: f= 714.543, eps=0.006067607
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Epoch 88: f= 714.482, eps=0.008537733
Epoch 89: f= 714.474, eps=0.008964619
Epoch 90: f= 714.466, eps=0.009412850
Epoch 91: f= 714.462, eps=0.009883493
Epoch 92: f= 714.495, eps=0.004941746
Epoch 93: f= 714.507, eps=0.002470873
Epoch 94: f= 714.447, eps=0.002594417
Epoch 95: f= 714.445, eps=0.002724138
Epoch 96: f= 714.443, eps=0.002860345
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Epoch 100: f= 714.436, eps=0.003476767
Epoch 101: f= 714.434, eps=0.003650605
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Epoch 104: f= 714.429, eps=0.004226032
Epoch 105: f= 714.427, eps=0.004437333
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Epoch 107: f= 714.423, eps=0.004892160
Epoch 108: f= 714.421, eps=0.005136768
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Epoch 110: f= 714.417, eps=0.005663287
Epoch 111: f= 714.415, eps=0.005946451

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Epoch 113: f= 714.411, eps=0.006555962
Epoch 114: f= 714.409, eps=0.006883760
Epoch 115: f= 714.407, eps=0.007227948
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Epoch 202: f= 714.381, eps=0.005877170
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Epoch 208: f= 714.381, eps=0.007875970
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Epoch 223: f= 714.381, eps=0.003712829
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Epoch 496: f= 714.380, eps=0.003584564
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 Result after 500 epochs: f=714.3804990993457
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 Epoch 2: f= 3076.838, eps=0.011025000
 Epoch 3: f= 2083.891, eps=0.011576250
 Epoch 4: f= 1499.379, eps=0.012155063
 Epoch 5: f= 1195.530, eps=0.012762816
 Epoch 6: f= 1019.030, eps=0.013400956
 Epoch 7: f= 953.913, eps=0.014071004
 Epoch 8: f= 1182.814, eps=0.007035502
 Epoch 9: f= 1289.182, eps=0.003517751
 Epoch 10: f= 932.116, eps=0.003693639
 Epoch 11: f= 816.850, eps=0.003878321
 Epoch 12: f= 787.315, eps=0.004072237
 Epoch 13: f= 773.170, eps=0.004275848
 Epoch 14: f= 763.643, eps=0.004489641
 Epoch 15: f= 756.260, eps=0.004714123
 Epoch 16: f= 750.180, eps=0.004949829
 Epoch 17: f= 745.068, eps=0.005197320
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 Epoch 19: f= 737.116, eps=0.005730046
 Epoch 20: f= 734.094, eps=0.006016548
 Epoch 21: f= 731.615, eps=0.006317375
 Epoch 22: f= 729.613, eps=0.006633244
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 Epoch 37: f= 723.424, eps=0.003126993
 Epoch 38: f= 723.374, eps=0.003283342
 Epoch 39: f= 723.326, eps=0.003447510
 Epoch 40: f= 723.278, eps=0.003619885
 Epoch 41: f= 723.232, eps=0.003800879
 Epoch 42: f= 723.187, eps=0.003990923

Epoch 43: f= 723.143, eps=0.004190469
Epoch 44: f= 723.101, eps=0.004399993
Epoch 45: f= 723.059, eps=0.004619993
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Epoch 67: f= 722.536, eps=0.003064554
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Epoch 87: f= 722.405, eps=0.003871988
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Epoch 90: f= 722.401, eps=0.004482310

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Epoch 475: f= 722.372, eps=0.002701969
 Epoch 476: f= 722.372, eps=0.002837067
 Epoch 477: f= 722.372, eps=0.002978921
 Epoch 478: f= 722.372, eps=0.003127867
 Epoch 479: f= 722.372, eps=0.003284260
 Epoch 480: f= 722.372, eps=0.003448473
 Epoch 481: f= 722.372, eps=0.003620897
 Epoch 482: f= 722.372, eps=0.003801941
 Epoch 483: f= 722.372, eps=0.003992039
 Epoch 484: f= 722.372, eps=0.004191640
 Epoch 485: f= 722.372, eps=0.004401222
 Epoch 486: f= 722.372, eps=0.004621284
 Epoch 487: f= 722.372, eps=0.004852348
 Epoch 488: f= 722.372, eps=0.005094965
 Epoch 489: f= 722.372, eps=0.005349713
 Epoch 490: f= 722.372, eps=0.005617199
 Epoch 491: f= 722.372, eps=0.005898059
 Epoch 492: f= 722.372, eps=0.006192962
 Epoch 493: f= 722.372, eps=0.006502610
 Epoch 494: f= 722.372, eps=0.006827741
 Epoch 495: f= 722.372, eps=0.007169128
 Epoch 496: f= 722.372, eps=0.007527584
 Epoch 497: f= 722.372, eps=0.007863792
 Epoch 498: f= 722.372, eps=0.008219182
 Epoch 499: f= 722.372, eps=0.008595581
 Result after 500 epochs: f=722.3720587338794
 Epoch 0: f= 6971.823, eps=0.010000000
 Epoch 1: f= 5884.379, eps=0.010500000
 Epoch 2: f= 3362.081, eps=0.011025000
 Epoch 3: f= 2071.367, eps=0.011576250
 Epoch 4: f= 1422.221, eps=0.012155063
 Epoch 5: f= 1117.981, eps=0.012762816
 Epoch 6: f= 1121.186, eps=0.006381408
 Epoch 7: f= 1103.258, eps=0.006700478
 Epoch 8: f= 912.910, eps=0.007035502
 Epoch 9: f= 960.266, eps=0.003517751
 Epoch 10: f= 802.075, eps=0.003693639
 Epoch 11: f= 788.727, eps=0.003878321
 Epoch 12: f= 780.836, eps=0.004072237
 Epoch 13: f= 774.777, eps=0.004275848
 Epoch 14: f= 770.021, eps=0.004489641
 Epoch 15: f= 766.302, eps=0.004714123
 Epoch 16: f= 763.437, eps=0.004949829
 Epoch 17: f= 761.272, eps=0.005197320
 Epoch 18: f= 759.693, eps=0.005457186
 Epoch 19: f= 758.642, eps=0.005730046
 Epoch 20: f= 758.257, eps=0.006016548
 Epoch 21: f= 759.378, eps=0.003008274

Epoch	22:	f=	757.011,	eps=0.003158688
Epoch	23:	f=	756.515,	eps=0.003316622
Epoch	24:	f=	756.267,	eps=0.003482453
Epoch	25:	f=	756.087,	eps=0.003656576
Epoch	26:	f=	755.936,	eps=0.003839405
Epoch	27:	f=	755.806,	eps=0.004031375
Epoch	28:	f=	755.692,	eps=0.004232944
Epoch	29:	f=	755.591,	eps=0.004444591
Epoch	30:	f=	755.503,	eps=0.004666820
Epoch	31:	f=	755.425,	eps=0.004900161
Epoch	32:	f=	755.361,	eps=0.005145169
Epoch	33:	f=	755.314,	eps=0.005402428
Epoch	34:	f=	755.306,	eps=0.005672549
Epoch	35:	f=	755.414,	eps=0.002836275
Epoch	36:	f=	755.180,	eps=0.002978088
Epoch	37:	f=	755.134,	eps=0.003126993
Epoch	38:	f=	755.109,	eps=0.003283342
Epoch	39:	f=	755.088,	eps=0.003447510
Epoch	40:	f=	755.068,	eps=0.003619885
Epoch	41:	f=	755.049,	eps=0.003800879
Epoch	42:	f=	755.031,	eps=0.003990923
Epoch	43:	f=	755.014,	eps=0.004190469
Epoch	44:	f=	754.998,	eps=0.004399993
Epoch	45:	f=	754.983,	eps=0.004619993
Epoch	46:	f=	754.969,	eps=0.004850992
Epoch	47:	f=	754.956,	eps=0.005093542
Epoch	48:	f=	754.944,	eps=0.005348219
Epoch	49:	f=	754.933,	eps=0.005615630
Epoch	50:	f=	754.924,	eps=0.005896411
Epoch	51:	f=	754.921,	eps=0.006191232
Epoch	52:	f=	754.937,	eps=0.003095616
Epoch	53:	f=	754.908,	eps=0.003250397
Epoch	54:	f=	754.899,	eps=0.003412917
Epoch	55:	f=	754.894,	eps=0.003583562
Epoch	56:	f=	754.890,	eps=0.003762741
Epoch	57:	f=	754.887,	eps=0.003950878
Epoch	58:	f=	754.883,	eps=0.004148421
Epoch	59:	f=	754.881,	eps=0.004355843
Epoch	60:	f=	754.878,	eps=0.004573635
Epoch	61:	f=	754.875,	eps=0.004802316
Epoch	62:	f=	754.873,	eps=0.005042432
Epoch	63:	f=	754.871,	eps=0.005294554
Epoch	64:	f=	754.871,	eps=0.005559282
Epoch	65:	f=	754.875,	eps=0.002779641
Epoch	66:	f=	754.866,	eps=0.002918623
Epoch	67:	f=	754.864,	eps=0.003064554
Epoch	68:	f=	754.863,	eps=0.003217782
Epoch	69:	f=	754.863,	eps=0.003378671

Epoch 70: f= 754.862, eps=0.003547604
Epoch 71: f= 754.861, eps=0.003724984
Epoch 72: f= 754.860, eps=0.003911234
Epoch 73: f= 754.860, eps=0.004106795
Epoch 74: f= 754.859, eps=0.004312135
Epoch 75: f= 754.858, eps=0.004527742
Epoch 76: f= 754.858, eps=0.004754129
Epoch 77: f= 754.857, eps=0.004991835
Epoch 78: f= 754.857, eps=0.005241427
Epoch 79: f= 754.856, eps=0.005503499
Epoch 80: f= 754.856, eps=0.005778674
Epoch 81: f= 754.855, eps=0.006067607
Epoch 82: f= 754.855, eps=0.006370988
Epoch 83: f= 754.856, eps=0.003185494
Epoch 84: f= 754.855, eps=0.003344768
Epoch 85: f= 754.854, eps=0.003512007
Epoch 86: f= 754.854, eps=0.003687607
Epoch 87: f= 754.854, eps=0.003871988
Epoch 88: f= 754.854, eps=0.004065587
Epoch 89: f= 754.854, eps=0.004268866
Epoch 90: f= 754.854, eps=0.004482310
Epoch 91: f= 754.854, eps=0.004706425
Epoch 92: f= 754.853, eps=0.004941746
Epoch 93: f= 754.853, eps=0.005188834
Epoch 94: f= 754.853, eps=0.002594417
Epoch 95: f= 754.853, eps=0.002724138
Epoch 96: f= 754.853, eps=0.002860345
Epoch 97: f= 754.853, eps=0.003003362
Epoch 98: f= 754.853, eps=0.003153530
Epoch 99: f= 754.853, eps=0.003311206
Epoch 100: f= 754.853, eps=0.003476767
Epoch 101: f= 754.853, eps=0.003650605
Epoch 102: f= 754.853, eps=0.003833135
Epoch 103: f= 754.853, eps=0.004024792
Epoch 104: f= 754.853, eps=0.004226032
Epoch 105: f= 754.853, eps=0.004437333
Epoch 106: f= 754.853, eps=0.004659200
Epoch 107: f= 754.853, eps=0.004892160
Epoch 108: f= 754.853, eps=0.005136768
Epoch 109: f= 754.853, eps=0.005393606
Epoch 110: f= 754.853, eps=0.005663287
Epoch 111: f= 754.853, eps=0.005946451
Epoch 112: f= 754.853, eps=0.006243773
Epoch 113: f= 754.853, eps=0.006555962
Epoch 114: f= 754.853, eps=0.006883760
Epoch 115: f= 754.853, eps=0.007227948
Epoch 116: f= 754.853, eps=0.003613974
Epoch 117: f= 754.853, eps=0.003794673

Epoch 118: f= 754.853, eps=0.003984406
Epoch 119: f= 754.852, eps=0.004183627
Epoch 120: f= 754.852, eps=0.004392808
Epoch 121: f= 754.852, eps=0.004612449
Epoch 122: f= 754.852, eps=0.002306224
Epoch 123: f= 754.852, eps=0.002421535
Epoch 124: f= 754.852, eps=0.002542612
Epoch 125: f= 754.852, eps=0.002669743
Epoch 126: f= 754.852, eps=0.002803230
Epoch 127: f= 754.852, eps=0.002943392
Epoch 128: f= 754.852, eps=0.003090561
Epoch 129: f= 754.852, eps=0.003245089
Epoch 130: f= 754.852, eps=0.003407344
Epoch 131: f= 754.852, eps=0.003577711
Epoch 132: f= 754.852, eps=0.003756596
Epoch 133: f= 754.852, eps=0.003944426
Epoch 134: f= 754.852, eps=0.004141647
Epoch 135: f= 754.852, eps=0.004348730
Epoch 136: f= 754.852, eps=0.004566166
Epoch 137: f= 754.852, eps=0.004794475
Epoch 138: f= 754.852, eps=0.005034198
Epoch 139: f= 754.852, eps=0.005285908
Epoch 140: f= 754.852, eps=0.005550204
Epoch 141: f= 754.852, eps=0.005827714
Epoch 142: f= 754.852, eps=0.006119100
Epoch 143: f= 754.852, eps=0.006425055
Epoch 144: f= 754.852, eps=0.006746307
Epoch 145: f= 754.852, eps=0.007083623
Epoch 146: f= 754.852, eps=0.007437804
Epoch 147: f= 754.852, eps=0.007809694
Epoch 148: f= 754.852, eps=0.008200179
Epoch 149: f= 754.852, eps=0.008610188
Epoch 150: f= 754.852, eps=0.004305094
Epoch 151: f= 754.852, eps=0.004520348
Epoch 152: f= 754.852, eps=0.002260174
Epoch 153: f= 754.852, eps=0.002373183
Epoch 154: f= 754.852, eps=0.002491842
Epoch 155: f= 754.852, eps=0.002616434
Epoch 156: f= 754.852, eps=0.002747256
Epoch 157: f= 754.852, eps=0.002884619
Epoch 158: f= 754.852, eps=0.003028850
Epoch 159: f= 754.852, eps=0.003180292
Epoch 160: f= 754.852, eps=0.003339307
Epoch 161: f= 754.852, eps=0.003506272
Epoch 162: f= 754.852, eps=0.003681586
Epoch 163: f= 754.852, eps=0.003865665
Epoch 164: f= 754.852, eps=0.004058948
Epoch 165: f= 754.852, eps=0.004261896

Epoch 166: f= 754.852, eps=0.004474990
Epoch 167: f= 754.852, eps=0.004698740
Epoch 168: f= 754.852, eps=0.004933677
Epoch 169: f= 754.852, eps=0.005180361
Epoch 170: f= 754.852, eps=0.005439379
Epoch 171: f= 754.852, eps=0.005711348
Epoch 172: f= 754.852, eps=0.005996915
Epoch 173: f= 754.852, eps=0.006296761
Epoch 174: f= 754.852, eps=0.006611599
Epoch 175: f= 754.852, eps=0.006942179
Epoch 176: f= 754.852, eps=0.007289288
Epoch 177: f= 754.852, eps=0.007653752
Epoch 178: f= 754.852, eps=0.008036440
Epoch 179: f= 754.852, eps=0.008438262
Epoch 180: f= 754.852, eps=0.008860175
Epoch 181: f= 754.852, eps=0.009303184
Epoch 182: f= 754.852, eps=0.004651592
Epoch 183: f= 754.852, eps=0.002325796
Epoch 184: f= 754.852, eps=0.002442086
Epoch 185: f= 754.852, eps=0.002564190
Epoch 186: f= 754.852, eps=0.002692399
Epoch 187: f= 754.852, eps=0.002827019
Epoch 188: f= 754.852, eps=0.002968370
Epoch 189: f= 754.852, eps=0.003116789
Epoch 190: f= 754.852, eps=0.003272628
Epoch 191: f= 754.852, eps=0.003436260
Epoch 192: f= 754.852, eps=0.003608073
Epoch 193: f= 754.852, eps=0.003788476
Epoch 194: f= 754.852, eps=0.003977900
Epoch 195: f= 754.852, eps=0.004176795
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Epoch 197: f= 754.852, eps=0.004604917
Epoch 198: f= 754.852, eps=0.004835163
Epoch 199: f= 754.852, eps=0.005076921
Epoch 200: f= 754.852, eps=0.005330767
Epoch 201: f= 754.852, eps=0.005597305
Epoch 202: f= 754.852, eps=0.005877170
Epoch 203: f= 754.852, eps=0.006171029
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Epoch 207: f= 754.852, eps=0.007500924
Epoch 208: f= 754.852, eps=0.007875970
Epoch 209: f= 754.852, eps=0.008269769
Epoch 210: f= 754.852, eps=0.004134885
Epoch 211: f= 754.852, eps=0.004341629
Epoch 212: f= 754.852, eps=0.002170814
Epoch 213: f= 754.852, eps=0.002279355

Epoch 214: f= 754.852, eps=0.002393323
Epoch 215: f= 754.852, eps=0.002512989
Epoch 216: f= 754.852, eps=0.002638638
Epoch 217: f= 754.852, eps=0.002770570
Epoch 218: f= 754.852, eps=0.002909099
Epoch 219: f= 754.852, eps=0.003054554
Epoch 220: f= 754.852, eps=0.003207282
Epoch 221: f= 754.852, eps=0.003367646
Epoch 222: f= 754.852, eps=0.003536028
Epoch 223: f= 754.852, eps=0.003712829
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Epoch 225: f= 754.852, eps=0.004093394
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Epoch 227: f= 754.852, eps=0.004512967
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Epoch 233: f= 754.852, eps=0.006047808
Epoch 234: f= 754.852, eps=0.006350198
Epoch 235: f= 754.852, eps=0.006667708
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Epoch 237: f= 754.852, eps=0.007351148
Epoch 238: f= 754.852, eps=0.007718705
Epoch 239: f= 754.852, eps=0.008104641
Epoch 240: f= 754.852, eps=0.008509873
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Epoch 242: f= 754.852, eps=0.009382135
Epoch 243: f= 754.852, eps=0.009851241
Epoch 244: f= 754.852, eps=0.004925621
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Epoch 246: f= 754.852, eps=0.002585951
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Epoch 248: f= 754.852, eps=0.002851011
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Epoch 251: f= 754.852, eps=0.003300401
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Epoch 256: f= 754.852, eps=0.004212241
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Epoch 259: f= 754.852, eps=0.004876196
Epoch 260: f= 754.852, eps=0.005120006
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Epoch 262: f= 754.852, eps=0.005644806
Epoch 263: f= 754.852, eps=0.005927047
Epoch 264: f= 754.852, eps=0.006223399
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Epoch 269: f= 754.852, eps=0.003782290
Epoch 270: f= 754.852, eps=0.003971405
Epoch 271: f= 754.852, eps=0.004169975
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Epoch 273: f= 754.852, eps=0.004597397
Epoch 274: f= 754.852, eps=0.002298699
Epoch 275: f= 754.852, eps=0.002413634
Epoch 276: f= 754.852, eps=0.002534315
Epoch 277: f= 754.852, eps=0.002661031
Epoch 278: f= 754.852, eps=0.002794083
Epoch 279: f= 754.852, eps=0.002933787
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Epoch 297: f= 754.852, eps=0.007060508
Epoch 298: f= 754.852, eps=0.007413533
Epoch 299: f= 754.852, eps=0.007784210
Epoch 300: f= 754.852, eps=0.008173420
Epoch 301: f= 754.852, eps=0.008582091
Epoch 302: f= 754.852, eps=0.009011196
Epoch 303: f= 754.852, eps=0.004505598
Epoch 304: f= 754.852, eps=0.002252799
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Epoch 306: f= 754.852, eps=0.002483711
Epoch 307: f= 754.852, eps=0.002607896
Epoch 308: f= 754.852, eps=0.002738291
Epoch 309: f= 754.852, eps=0.002875206

Epoch 310: f= 754.852, eps=0.003018966
Epoch 311: f= 754.852, eps=0.003169914
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Epoch 314: f= 754.852, eps=0.003669572
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Epoch 316: f= 754.852, eps=0.001926525
Epoch 317: f= 754.852, eps=0.002022852
Epoch 318: f= 754.852, eps=0.002123994
Epoch 319: f= 754.852, eps=0.002230194
Epoch 320: f= 754.852, eps=0.002341704
Epoch 321: f= 754.852, eps=0.002458789
Epoch 322: f= 754.852, eps=0.001229394
Epoch 323: f= 754.852, eps=0.001290864
Epoch 324: f= 754.852, eps=0.001355407
Epoch 325: f= 754.852, eps=0.001423178
Epoch 326: f= 754.852, eps=0.001494337
Epoch 327: f= 754.852, eps=0.001569053
Epoch 328: f= 754.852, eps=0.001647506
Epoch 329: f= 754.852, eps=0.001729881
Epoch 330: f= 754.852, eps=0.001816375
Epoch 331: f= 754.852, eps=0.001907194
Epoch 332: f= 754.852, eps=0.002002554
Epoch 333: f= 754.852, eps=0.002102682
Epoch 334: f= 754.852, eps=0.002207816
Epoch 335: f= 754.852, eps=0.001103908
Epoch 336: f= 754.852, eps=0.001159103
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Epoch 344: f= 754.852, eps=0.000388327
Epoch 345: f= 754.852, eps=0.000407744
Epoch 346: f= 754.852, eps=0.000428131
Epoch 347: f= 754.852, eps=0.000214065
Epoch 348: f= 754.852, eps=0.000224769
Epoch 349: f= 754.852, eps=0.000236007
Epoch 350: f= 754.852, eps=0.000247807
Epoch 351: f= 754.852, eps=0.000123904
Epoch 352: f= 754.852, eps=0.000130099
Epoch 353: f= 754.852, eps=0.000065049
Epoch 354: f= 754.852, eps=0.000068302
Epoch 355: f= 754.852, eps=0.000071717
Epoch 356: f= 754.852, eps=0.000035859
Epoch 357: f= 754.852, eps=0.000037651

Epoch 358: f= 754.852, eps=0.000039534
Epoch 359: f= 754.852, eps=0.000019767
Epoch 360: f= 754.852, eps=0.000020755
Epoch 361: f= 754.852, eps=0.000010378
Epoch 362: f= 754.852, eps=0.000010897
Epoch 363: f= 754.852, eps=0.000011441
Epoch 364: f= 754.852, eps=0.000005721
Epoch 365: f= 754.852, eps=0.000006007
Epoch 366: f= 754.852, eps=0.000006307
Epoch 367: f= 754.852, eps=0.000003154
Epoch 368: f= 754.852, eps=0.000003311
Epoch 369: f= 754.852, eps=0.000003477
Epoch 370: f= 754.852, eps=0.000003651
Epoch 371: f= 754.852, eps=0.000001825
Epoch 372: f= 754.852, eps=0.000001917
Epoch 373: f= 754.852, eps=0.000000958
Epoch 374: f= 754.852, eps=0.000001006
Epoch 375: f= 754.852, eps=0.000000503
Epoch 376: f= 754.852, eps=0.000000528
Epoch 377: f= 754.852, eps=0.000000555
Epoch 378: f= 754.852, eps=0.000000582
Epoch 379: f= 754.852, eps=0.000000612
Epoch 380: f= 754.852, eps=0.000000642
Epoch 381: f= 754.852, eps=0.000000674
Epoch 382: f= 754.852, eps=0.000000708
Epoch 383: f= 754.852, eps=0.000000743
Epoch 384: f= 754.852, eps=0.000000372
Epoch 385: f= 754.852, eps=0.000000390
Epoch 386: f= 754.852, eps=0.000000410
Epoch 387: f= 754.852, eps=0.000000430
Epoch 388: f= 754.852, eps=0.000000452
Epoch 389: f= 754.852, eps=0.000000474
Epoch 390: f= 754.852, eps=0.000000237
Epoch 391: f= 754.852, eps=0.000000249
Epoch 392: f= 754.852, eps=0.000000261
Epoch 393: f= 754.852, eps=0.000000275
Epoch 394: f= 754.852, eps=0.000000288
Epoch 395: f= 754.852, eps=0.000000303
Epoch 396: f= 754.852, eps=0.000000318
Epoch 397: f= 754.852, eps=0.000000334
Epoch 398: f= 754.852, eps=0.000000167
Epoch 399: f= 754.852, eps=0.000000175
Epoch 400: f= 754.852, eps=0.000000088
Epoch 401: f= 754.852, eps=0.000000092
Epoch 402: f= 754.852, eps=0.000000046
Epoch 403: f= 754.852, eps=0.000000048
Epoch 404: f= 754.852, eps=0.000000051
Epoch 405: f= 754.852, eps=0.000000025

Epoch 406: f= 754.852, eps=0.000000027
Epoch 407: f= 754.852, eps=0.000000028
Epoch 408: f= 754.852, eps=0.000000029
Epoch 409: f= 754.852, eps=0.000000031
Epoch 410: f= 754.852, eps=0.000000015
Epoch 411: f= 754.852, eps=0.000000016
Epoch 412: f= 754.852, eps=0.000000008
Epoch 413: f= 754.852, eps=0.000000008
Epoch 414: f= 754.852, eps=0.000000009
Epoch 415: f= 754.852, eps=0.000000004
Epoch 416: f= 754.852, eps=0.000000005
Epoch 417: f= 754.852, eps=0.000000005
Epoch 418: f= 754.852, eps=0.000000005
Epoch 419: f= 754.852, eps=0.000000003
Epoch 420: f= 754.852, eps=0.000000003
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Epoch 425: f= 754.852, eps=0.000000002
Epoch 426: f= 754.852, eps=0.000000001
Epoch 427: f= 754.852, eps=0.000000001
Epoch 428: f= 754.852, eps=0.000000001
Epoch 429: f= 754.852, eps=0.000000001
Epoch 430: f= 754.852, eps=0.000000001
Epoch 431: f= 754.852, eps=0.000000001
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Epoch 437: f= 754.852, eps=0.000000001
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Epoch 440: f= 754.852, eps=0.000000000
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Epoch 450: f= 754.852, eps=0.000000001
Epoch 451: f= 754.852, eps=0.000000001
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Epoch 453: f= 754.852, eps=0.000000001

Epoch 454: f= 754.852, eps=0.000000001
Epoch 455: f= 754.852, eps=0.000000001
Epoch 456: f= 754.852, eps=0.000000001
Epoch 457: f= 754.852, eps=0.000000001
Epoch 458: f= 754.852, eps=0.000000000
Epoch 459: f= 754.852, eps=0.000000000
Epoch 460: f= 754.852, eps=0.000000000
Epoch 461: f= 754.852, eps=0.000000000
Epoch 462: f= 754.852, eps=0.000000000
Epoch 463: f= 754.852, eps=0.000000000
Epoch 464: f= 754.852, eps=0.000000000
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Epoch 467: f= 754.852, eps=0.000000000
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Epoch 472: f= 754.852, eps=0.000000000
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Epoch 474: f= 754.852, eps=0.000000000
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Epoch 476: f= 754.852, eps=0.000000000
Epoch 477: f= 754.852, eps=0.000000000
Epoch 478: f= 754.852, eps=0.000000000
Epoch 479: f= 754.852, eps=0.000000000
Epoch 480: f= 754.852, eps=0.000000000
Epoch 481: f= 754.852, eps=0.000000000
Epoch 482: f= 754.852, eps=0.000000000
Epoch 483: f= 754.852, eps=0.000000000
Epoch 484: f= 754.852, eps=0.000000000
Epoch 485: f= 754.852, eps=0.000000000
Epoch 486: f= 754.852, eps=0.000000000
Epoch 487: f= 754.852, eps=0.000000000
Epoch 488: f= 754.852, eps=0.000000000
Epoch 489: f= 754.852, eps=0.000000000
Epoch 490: f= 754.852, eps=0.000000000
Epoch 491: f= 754.852, eps=0.000000000
Epoch 492: f= 754.852, eps=0.000000000
Epoch 493: f= 754.852, eps=0.000000000
Epoch 494: f= 754.852, eps=0.000000000
Epoch 495: f= 754.852, eps=0.000000000
Epoch 496: f= 754.852, eps=0.000000000
Epoch 497: f= 754.852, eps=0.000000000
Epoch 498: f= 754.852, eps=0.000000000
Epoch 499: f= 754.852, eps=0.000000000
Result after 500 epochs: f=754.8524204027967
Epoch 0: f= 7307.438, eps=0.010000000

Epoch	1:	f=	7566.155,	eps=0.005000000
Epoch	2:	f=	5325.636,	eps=0.005250000
Epoch	3:	f=	3761.037,	eps=0.005512500
Epoch	4:	f=	2648.710,	eps=0.005788125
Epoch	5:	f=	1878.665,	eps=0.006077531
Epoch	6:	f=	1406.862,	eps=0.006381408
Epoch	7:	f=	1127.193,	eps=0.006700478
Epoch	8:	f=	964.727,	eps=0.007035502
Epoch	9:	f=	882.554,	eps=0.007387277
Epoch	10:	f=	875.652,	eps=0.007756641
Epoch	11:	f=	1024.660,	eps=0.003878321
Epoch	12:	f=	834.536,	eps=0.004072237
Epoch	13:	f=	819.226,	eps=0.004275848
Epoch	14:	f=	817.127,	eps=0.004489641
Epoch	15:	f=	821.922,	eps=0.002244820
Epoch	16:	f=	804.290,	eps=0.002357061
Epoch	17:	f=	803.780,	eps=0.002474914
Epoch	18:	f=	803.425,	eps=0.002598660
Epoch	19:	f=	803.142,	eps=0.002728593
Epoch	20:	f=	802.913,	eps=0.002865023
Epoch	21:	f=	802.727,	eps=0.003008274
Epoch	22:	f=	802.576,	eps=0.003158688
Epoch	23:	f=	802.452,	eps=0.003316622
Epoch	24:	f=	802.351,	eps=0.003482453
Epoch	25:	f=	802.269,	eps=0.003656576
Epoch	26:	f=	802.201,	eps=0.003839405
Epoch	27:	f=	802.145,	eps=0.004031375
Epoch	28:	f=	802.099,	eps=0.004232944
Epoch	29:	f=	802.062,	eps=0.004444591
Epoch	30:	f=	802.031,	eps=0.004666820
Epoch	31:	f=	802.005,	eps=0.004900161
Epoch	32:	f=	801.985,	eps=0.005145169
Epoch	33:	f=	801.968,	eps=0.005402428
Epoch	34:	f=	801.955,	eps=0.005672549
Epoch	35:	f=	801.945,	eps=0.005956177
Epoch	36:	f=	801.937,	eps=0.006253986
Epoch	37:	f=	801.931,	eps=0.006566685
Epoch	38:	f=	801.927,	eps=0.006895019
Epoch	39:	f=	801.932,	eps=0.003447510
Epoch	40:	f=	801.927,	eps=0.003619885
Epoch	41:	f=	801.925,	eps=0.003800879
Epoch	42:	f=	801.923,	eps=0.003990923
Epoch	43:	f=	801.924,	eps=0.001995462
Epoch	44:	f=	801.917,	eps=0.002095235
Epoch	45:	f=	801.917,	eps=0.002199996
Epoch	46:	f=	801.916,	eps=0.002309996
Epoch	47:	f=	801.916,	eps=0.002425496
Epoch	48:	f=	801.916,	eps=0.002546771

Epoch 49: f= 801.915, eps=0.002674109
Epoch 50: f= 801.915, eps=0.002807815
Epoch 51: f= 801.915, eps=0.002948206
Epoch 52: f= 801.914, eps=0.003095616
Epoch 53: f= 801.914, eps=0.003250397
Epoch 54: f= 801.914, eps=0.003412917
Epoch 55: f= 801.914, eps=0.003583562
Epoch 56: f= 801.914, eps=0.003762741
Epoch 57: f= 801.914, eps=0.003950878
Epoch 58: f= 801.913, eps=0.004148421
Epoch 59: f= 801.913, eps=0.004355843
Epoch 60: f= 801.913, eps=0.004573635
Epoch 61: f= 801.913, eps=0.004802316
Epoch 62: f= 801.913, eps=0.005042432
Epoch 63: f= 801.913, eps=0.005294554
Epoch 64: f= 801.913, eps=0.005559282
Epoch 65: f= 801.913, eps=0.005837246
Epoch 66: f= 801.913, eps=0.006129108
Epoch 67: f= 801.913, eps=0.006435563
Epoch 68: f= 801.913, eps=0.006757341
Epoch 69: f= 801.913, eps=0.007095208
Epoch 70: f= 801.913, eps=0.007449969
Epoch 71: f= 801.913, eps=0.007822467
Epoch 72: f= 801.913, eps=0.008213591
Epoch 73: f= 801.913, eps=0.008624270
Epoch 74: f= 801.913, eps=0.004312135
Epoch 75: f= 801.913, eps=0.002156068
Epoch 76: f= 801.913, eps=0.002263871
Epoch 77: f= 801.913, eps=0.002377064
Epoch 78: f= 801.913, eps=0.002495918
Epoch 79: f= 801.913, eps=0.002620714
Epoch 80: f= 801.913, eps=0.002751749
Epoch 81: f= 801.913, eps=0.002889337
Epoch 82: f= 801.913, eps=0.003033804
Epoch 83: f= 801.913, eps=0.003185494
Epoch 84: f= 801.913, eps=0.003344768
Epoch 85: f= 801.913, eps=0.003512007
Epoch 86: f= 801.913, eps=0.003687607
Epoch 87: f= 801.913, eps=0.003871988
Epoch 88: f= 801.913, eps=0.004065587
Epoch 89: f= 801.913, eps=0.004268866
Epoch 90: f= 801.913, eps=0.004482310
Epoch 91: f= 801.913, eps=0.004706425
Epoch 92: f= 801.913, eps=0.004941746
Epoch 93: f= 801.913, eps=0.005188834
Epoch 94: f= 801.913, eps=0.005448275
Epoch 95: f= 801.913, eps=0.005720689
Epoch 96: f= 801.913, eps=0.006006724

Epoch 97: f= 801.913, eps=0.006307060
Epoch 98: f= 801.913, eps=0.006622413
Epoch 99: f= 801.913, eps=0.006953533
Epoch 100: f= 801.913, eps=0.003476767
Epoch 101: f= 801.913, eps=0.003650605
Epoch 102: f= 801.913, eps=0.003833135
Epoch 103: f= 801.913, eps=0.004024792
Epoch 104: f= 801.913, eps=0.004226032
Epoch 105: f= 801.913, eps=0.002113016
Epoch 106: f= 801.913, eps=0.002218667
Epoch 107: f= 801.913, eps=0.002329600
Epoch 108: f= 801.913, eps=0.002446080
Epoch 109: f= 801.913, eps=0.002568384
Epoch 110: f= 801.913, eps=0.002696803
Epoch 111: f= 801.913, eps=0.002831643
Epoch 112: f= 801.913, eps=0.002973225
Epoch 113: f= 801.913, eps=0.003121887
Epoch 114: f= 801.913, eps=0.003277981
Epoch 115: f= 801.913, eps=0.003441880
Epoch 116: f= 801.913, eps=0.003613974
Epoch 117: f= 801.913, eps=0.003794673
Epoch 118: f= 801.913, eps=0.003984406
Epoch 119: f= 801.913, eps=0.004183627
Epoch 120: f= 801.913, eps=0.004392808
Epoch 121: f= 801.913, eps=0.004612449
Epoch 122: f= 801.913, eps=0.004843071
Epoch 123: f= 801.913, eps=0.005085225
Epoch 124: f= 801.913, eps=0.005339486
Epoch 125: f= 801.913, eps=0.005606460
Epoch 126: f= 801.913, eps=0.005886783
Epoch 127: f= 801.913, eps=0.006181122
Epoch 128: f= 801.913, eps=0.006490178
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Epoch 130: f= 801.913, eps=0.007155422
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Epoch 132: f= 801.913, eps=0.003756596
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Epoch 134: f= 801.913, eps=0.001972213
Epoch 135: f= 801.913, eps=0.002070824
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Epoch 137: f= 801.913, eps=0.002283083
Epoch 138: f= 801.913, eps=0.002397237
Epoch 139: f= 801.913, eps=0.002517099
Epoch 140: f= 801.913, eps=0.002642954
Epoch 141: f= 801.913, eps=0.002775102
Epoch 142: f= 801.913, eps=0.002913857
Epoch 143: f= 801.913, eps=0.003059550
Epoch 144: f= 801.913, eps=0.003212527

Epoch 145: f= 801.913, eps=0.003373154
Epoch 146: f= 801.913, eps=0.003541811
Epoch 147: f= 801.913, eps=0.003718902
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Epoch 149: f= 801.913, eps=0.004100089
Epoch 150: f= 801.913, eps=0.004305094
Epoch 151: f= 801.913, eps=0.004520348
Epoch 152: f= 801.913, eps=0.004746366
Epoch 153: f= 801.913, eps=0.004983684
Epoch 154: f= 801.913, eps=0.005232868
Epoch 155: f= 801.913, eps=0.005494512
Epoch 156: f= 801.913, eps=0.005769237
Epoch 157: f= 801.913, eps=0.006057699
Epoch 158: f= 801.913, eps=0.006360584
Epoch 159: f= 801.913, eps=0.006678613
Epoch 160: f= 801.913, eps=0.007012544
Epoch 161: f= 801.913, eps=0.007363171
Epoch 162: f= 801.913, eps=0.007731330
Epoch 163: f= 801.913, eps=0.008117896
Epoch 164: f= 801.913, eps=0.008523791
Epoch 165: f= 801.913, eps=0.008949981
Epoch 166: f= 801.913, eps=0.004474990
Epoch 167: f= 801.913, eps=0.002237495
Epoch 168: f= 801.913, eps=0.002349370
Epoch 169: f= 801.913, eps=0.002466838
Epoch 170: f= 801.913, eps=0.002590180
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Epoch 173: f= 801.913, eps=0.000679922
Epoch 174: f= 801.913, eps=0.000713918
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Epoch 177: f= 801.913, eps=0.000826450
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Epoch 179: f= 801.913, eps=0.000433886
Epoch 180: f= 801.913, eps=0.000455580
Epoch 181: f= 801.913, eps=0.000478360
Epoch 182: f= 801.913, eps=0.000502277
Epoch 183: f= 801.913, eps=0.000527391
Epoch 184: f= 801.913, eps=0.000553761
Epoch 185: f= 801.913, eps=0.000276880
Epoch 186: f= 801.913, eps=0.000290724
Epoch 187: f= 801.913, eps=0.000145362
Epoch 188: f= 801.913, eps=0.000152630
Epoch 189: f= 801.913, eps=0.000160262
Epoch 190: f= 801.913, eps=0.000168275
Epoch 191: f= 801.913, eps=0.000176689
Epoch 192: f= 801.913, eps=0.000185523

Epoch 193: f= 801.913, eps=0.000194799
Epoch 194: f= 801.913, eps=0.000097400
Epoch 195: f= 801.913, eps=0.000102270
Epoch 196: f= 801.913, eps=0.000107383
Epoch 197: f= 801.913, eps=0.000053692
Epoch 198: f= 801.913, eps=0.000056376
Epoch 199: f= 801.913, eps=0.000059195
Epoch 200: f= 801.913, eps=0.000029597
Epoch 201: f= 801.913, eps=0.000031077
Epoch 202: f= 801.913, eps=0.000032631
Epoch 203: f= 801.913, eps=0.000034263
Epoch 204: f= 801.913, eps=0.000035976
Epoch 205: f= 801.913, eps=0.000037775
Epoch 206: f= 801.913, eps=0.000039663
Epoch 207: f= 801.913, eps=0.000041647
Epoch 208: f= 801.913, eps=0.000043729
Epoch 209: f= 801.913, eps=0.000045915
Epoch 210: f= 801.913, eps=0.000022958
Epoch 211: f= 801.913, eps=0.000024106
Epoch 212: f= 801.913, eps=0.000025311
Epoch 213: f= 801.913, eps=0.000026576
Epoch 214: f= 801.913, eps=0.000013288
Epoch 215: f= 801.913, eps=0.000013953
Epoch 216: f= 801.913, eps=0.000006976
Epoch 217: f= 801.913, eps=0.000007325
Epoch 218: f= 801.913, eps=0.000007691
Epoch 219: f= 801.913, eps=0.000008076
Epoch 220: f= 801.913, eps=0.000008480
Epoch 221: f= 801.913, eps=0.000004240
Epoch 222: f= 801.913, eps=0.000004452
Epoch 223: f= 801.913, eps=0.000004674
Epoch 224: f= 801.913, eps=0.000002337
Epoch 225: f= 801.913, eps=0.000002454
Epoch 226: f= 801.913, eps=0.000002577
Epoch 227: f= 801.913, eps=0.000001288
Epoch 228: f= 801.913, eps=0.000000644
Epoch 229: f= 801.913, eps=0.000000676
Epoch 230: f= 801.913, eps=0.000000710
Epoch 231: f= 801.913, eps=0.000000746
Epoch 232: f= 801.913, eps=0.000000783
Epoch 233: f= 801.913, eps=0.000000392
Epoch 234: f= 801.913, eps=0.000000411
Epoch 235: f= 801.913, eps=0.000000432
Epoch 236: f= 801.913, eps=0.000000216
Epoch 237: f= 801.913, eps=0.000000227
Epoch 238: f= 801.913, eps=0.000000238
Epoch 239: f= 801.913, eps=0.000000119
Epoch 240: f= 801.913, eps=0.000000125

Epoch 241: f= 801.913, eps=0.000000062
Epoch 242: f= 801.913, eps=0.000000066
Epoch 243: f= 801.913, eps=0.000000069
Epoch 244: f= 801.913, eps=0.000000072
Epoch 245: f= 801.913, eps=0.000000076
Epoch 246: f= 801.913, eps=0.000000038
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Epoch 249: f= 801.913, eps=0.000000044
Epoch 250: f= 801.913, eps=0.000000022
Epoch 251: f= 801.913, eps=0.000000023
Epoch 252: f= 801.913, eps=0.000000012
Epoch 253: f= 801.913, eps=0.000000012
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Epoch 255: f= 801.913, eps=0.000000013
Epoch 256: f= 801.913, eps=0.000000014
Epoch 257: f= 801.913, eps=0.000000015
Epoch 258: f= 801.913, eps=0.000000007
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 Epoch 493: f= 801.913, eps=0.000000000
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 Epoch 495: f= 801.913, eps=0.000000000
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 Epoch 497: f= 801.913, eps=0.000000000
 Epoch 498: f= 801.913, eps=0.000000000
 Epoch 499: f= 801.913, eps=0.000000000
 Result after 500 epochs: f=801.9128109439285
 Epoch 0: f= 9992.358, eps=0.010000000
 Epoch 1: f= 23977.384, eps=0.005000000
 Epoch 2: f= 5534.851, eps=0.005250000
 Epoch 3: f= 1427.453, eps=0.005512500
 Epoch 4: f= 1131.716, eps=0.005788125
 Epoch 5: f= 1540.933, eps=0.002894063
 Epoch 6: f= 1323.168, eps=0.003038766
 Epoch 7: f= 1049.068, eps=0.003190704
 Epoch 8: f= 1067.960, eps=0.001595352
 Epoch 9: f= 989.861, eps=0.001675120
 Epoch 10: f= 988.742, eps=0.001758876
 Epoch 11: f= 988.585, eps=0.001846819
 Epoch 12: f= 988.539, eps=0.001939160
 Epoch 13: f= 988.522, eps=0.002036118
 Epoch 14: f= 988.516, eps=0.002137924
 Epoch 15: f= 988.513, eps=0.002244820
 Epoch 16: f= 988.512, eps=0.002357061
 Epoch 17: f= 988.512, eps=0.002474914
 Epoch 18: f= 988.512, eps=0.002598660
 Epoch 19: f= 988.512, eps=0.002728593
 Epoch 20: f= 988.512, eps=0.002865023
 Epoch 21: f= 988.512, eps=0.003008274
 Epoch 22: f= 988.512, eps=0.003158688
 Epoch 23: f= 988.512, eps=0.003316622
 Epoch 24: f= 988.512, eps=0.001658311
 Epoch 25: f= 988.512, eps=0.001741227
 Epoch 26: f= 988.512, eps=0.001828288
 Epoch 27: f= 988.512, eps=0.001919702

Epoch	28:	f=	988.512,	eps=0.002015687
Epoch	29:	f=	988.512,	eps=0.002116472
Epoch	30:	f=	988.512,	eps=0.002222295
Epoch	31:	f=	988.512,	eps=0.002333410
Epoch	32:	f=	988.512,	eps=0.002450081
Epoch	33:	f=	988.512,	eps=0.002572585
Epoch	34:	f=	988.512,	eps=0.002701214
Epoch	35:	f=	988.512,	eps=0.002836275
Epoch	36:	f=	988.512,	eps=0.002978088
Epoch	37:	f=	988.512,	eps=0.003126993
Epoch	38:	f=	988.512,	eps=0.003283342
Epoch	39:	f=	988.512,	eps=0.003447510
Epoch	40:	f=	988.512,	eps=0.003619885
Epoch	41:	f=	988.512,	eps=0.001809943
Epoch	42:	f=	988.512,	eps=0.001900440
Epoch	43:	f=	988.512,	eps=0.001995462
Epoch	44:	f=	988.512,	eps=0.002095235
Epoch	45:	f=	988.512,	eps=0.002199996
Epoch	46:	f=	988.512,	eps=0.002309996
Epoch	47:	f=	988.512,	eps=0.002425496
Epoch	48:	f=	988.512,	eps=0.002546771
Epoch	49:	f=	988.512,	eps=0.001273385
Epoch	50:	f=	988.512,	eps=0.001337055
Epoch	51:	f=	988.512,	eps=0.001403907
Epoch	52:	f=	988.512,	eps=0.001474103
Epoch	53:	f=	988.512,	eps=0.001547808
Epoch	54:	f=	988.512,	eps=0.000773904
Epoch	55:	f=	988.512,	eps=0.000812599
Epoch	56:	f=	988.512,	eps=0.000853229
Epoch	57:	f=	988.512,	eps=0.000426615
Epoch	58:	f=	988.512,	eps=0.000447945
Epoch	59:	f=	988.512,	eps=0.000470343
Epoch	60:	f=	988.512,	eps=0.000493860
Epoch	61:	f=	988.512,	eps=0.000246930
Epoch	62:	f=	988.512,	eps=0.000259276
Epoch	63:	f=	988.512,	eps=0.000272240
Epoch	64:	f=	988.512,	eps=0.000285852
Epoch	65:	f=	988.512,	eps=0.000142926
Epoch	66:	f=	988.512,	eps=0.000150072
Epoch	67:	f=	988.512,	eps=0.000157576
Epoch	68:	f=	988.512,	eps=0.000078788
Epoch	69:	f=	988.512,	eps=0.000082727
Epoch	70:	f=	988.512,	eps=0.000086864
Epoch	71:	f=	988.512,	eps=0.000043432
Epoch	72:	f=	988.512,	eps=0.000045603
Epoch	73:	f=	988.512,	eps=0.000047884
Epoch	74:	f=	988.512,	eps=0.000023942
Epoch	75:	f=	988.512,	eps=0.000025139

Epoch	76:	f=	988.512,	eps=0.000026396
Epoch	77:	f=	988.512,	eps=0.000013198
Epoch	78:	f=	988.512,	eps=0.000013858
Epoch	79:	f=	988.512,	eps=0.000006929
Epoch	80:	f=	988.512,	eps=0.000007275
Epoch	81:	f=	988.512,	eps=0.000007639
Epoch	82:	f=	988.512,	eps=0.000008021
Epoch	83:	f=	988.512,	eps=0.000004011
Epoch	84:	f=	988.512,	eps=0.000004211
Epoch	85:	f=	988.512,	eps=0.000004422
Epoch	86:	f=	988.512,	eps=0.000002211
Epoch	87:	f=	988.512,	eps=0.000002321
Epoch	88:	f=	988.512,	eps=0.000001161
Epoch	89:	f=	988.512,	eps=0.000001219
Epoch	90:	f=	988.512,	eps=0.000000609
Epoch	91:	f=	988.512,	eps=0.000000640
Epoch	92:	f=	988.512,	eps=0.000000672
Epoch	93:	f=	988.512,	eps=0.000000336
Epoch	94:	f=	988.512,	eps=0.000000353
Epoch	95:	f=	988.512,	eps=0.000000176
Epoch	96:	f=	988.512,	eps=0.000000185
Epoch	97:	f=	988.512,	eps=0.000000093
Epoch	98:	f=	988.512,	eps=0.000000097
Epoch	99:	f=	988.512,	eps=0.000000102
Epoch	100:	f=	988.512,	eps=0.000000107
Epoch	101:	f=	988.512,	eps=0.000000113
Epoch	102:	f=	988.512,	eps=0.000000056
Epoch	103:	f=	988.512,	eps=0.000000059
Epoch	104:	f=	988.512,	eps=0.000000062
Epoch	105:	f=	988.512,	eps=0.000000065
Epoch	106:	f=	988.512,	eps=0.000000068
Epoch	107:	f=	988.512,	eps=0.000000072
Epoch	108:	f=	988.512,	eps=0.000000075
Epoch	109:	f=	988.512,	eps=0.000000079
Epoch	110:	f=	988.512,	eps=0.000000083
Epoch	111:	f=	988.512,	eps=0.000000042
Epoch	112:	f=	988.512,	eps=0.000000044
Epoch	113:	f=	988.512,	eps=0.000000046
Epoch	114:	f=	988.512,	eps=0.000000023
Epoch	115:	f=	988.512,	eps=0.000000024
Epoch	116:	f=	988.512,	eps=0.000000025
Epoch	117:	f=	988.512,	eps=0.000000013
Epoch	118:	f=	988.512,	eps=0.000000013
Epoch	119:	f=	988.512,	eps=0.000000014
Epoch	120:	f=	988.512,	eps=0.000000015
Epoch	121:	f=	988.512,	eps=0.000000007
Epoch	122:	f=	988.512,	eps=0.000000008
Epoch	123:	f=	988.512,	eps=0.000000004

Epoch 124: f= 988.512, eps=0.000000004
Epoch 125: f= 988.512, eps=0.000000002
Epoch 126: f= 988.512, eps=0.000000002
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Epoch 498: f= 988.512, eps=0.000000000
Epoch 499: f= 988.512, eps=0.000000000
Result after 500 epochs: f=988.511839602703
Epoch 0: f= 13348.508, eps=0.010000000
Epoch 1: f= 63618.781, eps=0.005000000
Epoch 2: f= 5529.171, eps=0.005250000
Epoch 3: f= 25633.447, eps=0.002625000
Epoch 4: f= 5261.229, eps=0.002756250
Epoch 5: f= 1444.512, eps=0.002894063
Epoch 6: f= 1140.676, eps=0.003038766

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Epoch 7: f= 1140.260, eps=0.003190704
Epoch 8: f= 1154.808, eps=0.001595352
Epoch 9: f= 1112.206, eps=0.001675120
Epoch 10: f= 1110.068, eps=0.001758876
Epoch 11: f= 1109.401, eps=0.001846819
Epoch 12: f= 1109.220, eps=0.001939160
Epoch 13: f= 1109.135, eps=0.002036118
Epoch 14: f= 1109.118, eps=0.002137924
Epoch 15: f= 1109.127, eps=0.001068962
Epoch 16: f= 1108.946, eps=0.001122410
Epoch 17: f= 1108.946, eps=0.001178531
Epoch 18: f= 1108.946, eps=0.001237457
Epoch 19: f= 1108.946, eps=0.001299330
Epoch 20: f= 1108.946, eps=0.001364297
Epoch 21: f= 1108.946, eps=0.001432511
Epoch 22: f= 1108.946, eps=0.001504137
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Epoch 25: f= 1108.946, eps=0.001741227
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Epoch 27: f= 1108.946, eps=0.001919702
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Epoch 42: f= 1108.946, eps=0.001900440
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Epoch 391: f= 1108.946, eps=0.000010170
Epoch 392: f= 1108.946, eps=0.000010679
Epoch 393: f= 1108.946, eps=0.000011213
Epoch 394: f= 1108.946, eps=0.000011774
Epoch 395: f= 1108.946, eps=0.000012362
Epoch 396: f= 1108.946, eps=0.000012980
Epoch 397: f= 1108.946, eps=0.000013629
Epoch 398: f= 1108.946, eps=0.000014311
Epoch 399: f= 1108.946, eps=0.000015026
Epoch 400: f= 1108.946, eps=0.000007513
Epoch 401: f= 1108.946, eps=0.000007889
Epoch 402: f= 1108.946, eps=0.000008283
Epoch 403: f= 1108.946, eps=0.000008697
Epoch 404: f= 1108.946, eps=0.000004349
Epoch 405: f= 1108.946, eps=0.000004566
Epoch 406: f= 1108.946, eps=0.000004794
Epoch 407: f= 1108.946, eps=0.000005034
Epoch 408: f= 1108.946, eps=0.000005286
Epoch 409: f= 1108.946, eps=0.000005550
Epoch 410: f= 1108.946, eps=0.000005828
Epoch 411: f= 1108.946, eps=0.000006119
Epoch 412: f= 1108.946, eps=0.000003060
Epoch 413: f= 1108.946, eps=0.000003213
Epoch 414: f= 1108.946, eps=0.000003373
Epoch 415: f= 1108.946, eps=0.000001687
Epoch 416: f= 1108.946, eps=0.000001771
Epoch 417: f= 1108.946, eps=0.000001859
Epoch 418: f= 1108.946, eps=0.000000930
Epoch 419: f= 1108.946, eps=0.000000976
Epoch 420: f= 1108.946, eps=0.000001025
Epoch 421: f= 1108.946, eps=0.000001076
Epoch 422: f= 1108.946, eps=0.000001130
Epoch 423: f= 1108.946, eps=0.000001187
Epoch 424: f= 1108.946, eps=0.000001246
Epoch 425: f= 1108.946, eps=0.000001308
Epoch 426: f= 1108.946, eps=0.000001374
Epoch 427: f= 1108.946, eps=0.000001442
Epoch 428: f= 1108.946, eps=0.000001514
Epoch 429: f= 1108.946, eps=0.000001590
Epoch 430: f= 1108.946, eps=0.000001670
Epoch 431: f= 1108.946, eps=0.000001753
Epoch 432: f= 1108.946, eps=0.000001841
Epoch 433: f= 1108.946, eps=0.000001933
Epoch 434: f= 1108.946, eps=0.000000966
Epoch 435: f= 1108.946, eps=0.000001015
Epoch 436: f= 1108.946, eps=0.000001065
Epoch 437: f= 1108.946, eps=0.000001119
Epoch 438: f= 1108.946, eps=0.000001175

Epoch 439: f= 1108.946, eps=0.000001233
Epoch 440: f= 1108.946, eps=0.000001295
Epoch 441: f= 1108.946, eps=0.000001360
Epoch 442: f= 1108.946, eps=0.000001428
Epoch 443: f= 1108.946, eps=0.000001499
Epoch 444: f= 1108.946, eps=0.000001574
Epoch 445: f= 1108.946, eps=0.000001653
Epoch 446: f= 1108.946, eps=0.000001736
Epoch 447: f= 1108.946, eps=0.000001822
Epoch 448: f= 1108.946, eps=0.000001913
Epoch 449: f= 1108.946, eps=0.000002009
Epoch 450: f= 1108.946, eps=0.000002110
Epoch 451: f= 1108.946, eps=0.000002215
Epoch 452: f= 1108.946, eps=0.000002326
Epoch 453: f= 1108.946, eps=0.000002442
Epoch 454: f= 1108.946, eps=0.000002564
Epoch 455: f= 1108.946, eps=0.000002692
Epoch 456: f= 1108.946, eps=0.000002827
Epoch 457: f= 1108.946, eps=0.000002968
Epoch 458: f= 1108.946, eps=0.000003117
Epoch 459: f= 1108.946, eps=0.000003273
Epoch 460: f= 1108.946, eps=0.000003436
Epoch 461: f= 1108.946, eps=0.000003608
Epoch 462: f= 1108.946, eps=0.000003788
Epoch 463: f= 1108.946, eps=0.000003978
Epoch 464: f= 1108.946, eps=0.000004177
Epoch 465: f= 1108.946, eps=0.000004386
Epoch 466: f= 1108.946, eps=0.000004605
Epoch 467: f= 1108.946, eps=0.000004835
Epoch 468: f= 1108.946, eps=0.000005077
Epoch 469: f= 1108.946, eps=0.000005331
Epoch 470: f= 1108.946, eps=0.000005597
Epoch 471: f= 1108.946, eps=0.000005877
Epoch 472: f= 1108.946, eps=0.000006171
Epoch 473: f= 1108.946, eps=0.000006480
Epoch 474: f= 1108.946, eps=0.000006804
Epoch 475: f= 1108.946, eps=0.000007144
Epoch 476: f= 1108.946, eps=0.000007501
Epoch 477: f= 1108.946, eps=0.000007876
Epoch 478: f= 1108.946, eps=0.000008270
Epoch 479: f= 1108.946, eps=0.000008683
Epoch 480: f= 1108.946, eps=0.000004342
Epoch 481: f= 1108.946, eps=0.000004559
Epoch 482: f= 1108.946, eps=0.000004787
Epoch 483: f= 1108.946, eps=0.000005026
Epoch 484: f= 1108.946, eps=0.000005277
Epoch 485: f= 1108.946, eps=0.000005541
Epoch 486: f= 1108.946, eps=0.000005818

Epoch 487: f= 1108.946, eps=0.000006109
Epoch 488: f= 1108.946, eps=0.000006415
Epoch 489: f= 1108.946, eps=0.000006735
Epoch 490: f= 1108.946, eps=0.000007072
Epoch 491: f= 1108.946, eps=0.000007426
Epoch 492: f= 1108.946, eps=0.000007797
Epoch 493: f= 1108.946, eps=0.000008187
Epoch 494: f= 1108.946, eps=0.000008596
Epoch 495: f= 1108.946, eps=0.000004298
Epoch 496: f= 1108.946, eps=0.000004513
Epoch 497: f= 1108.946, eps=0.000004739
Epoch 498: f= 1108.946, eps=0.000004976
Epoch 499: f= 1108.946, eps=0.000005224
Result after 500 epochs: f=1108.9460399053748
Epoch 0: f= 23416.957, eps=0.010000000
Epoch 1: f=502022.764, eps=0.005000000
Epoch 2: f=1284214.042, eps=0.002500000
Epoch 3: f=136841.925, eps=0.002625000
Epoch 4: f= 37045.897, eps=0.002756250
Epoch 5: f= 45292.816, eps=0.001378125
Epoch 6: f= 4492.761, eps=0.001447031
Epoch 7: f= 1386.173, eps=0.001519383
Epoch 8: f= 1378.369, eps=0.001595352
Epoch 9: f= 1393.755, eps=0.000797676
Epoch 10: f= 1315.023, eps=0.000837560
Epoch 11: f= 1304.811, eps=0.000879438
Epoch 12: f= 1304.439, eps=0.000923410
Epoch 13: f= 1304.393, eps=0.000969580
Epoch 14: f= 1304.386, eps=0.001018059
Epoch 15: f= 1304.384, eps=0.001068962
Epoch 16: f= 1304.384, eps=0.001122410
Epoch 17: f= 1304.384, eps=0.001178531
Epoch 18: f= 1304.384, eps=0.001237457
Epoch 19: f= 1304.384, eps=0.001299330
Epoch 20: f= 1304.384, eps=0.000649665
Epoch 21: f= 1304.383, eps=0.000682148
Epoch 22: f= 1304.383, eps=0.000716256
Epoch 23: f= 1304.383, eps=0.000752069
Epoch 24: f= 1304.383, eps=0.000789672
Epoch 25: f= 1304.383, eps=0.000829156
Epoch 26: f= 1304.383, eps=0.000870613
Epoch 27: f= 1304.383, eps=0.000914144
Epoch 28: f= 1304.383, eps=0.000959851
Epoch 29: f= 1304.383, eps=0.001007844
Epoch 30: f= 1304.383, eps=0.001058236
Epoch 31: f= 1304.383, eps=0.001111148
Epoch 32: f= 1304.383, eps=0.001166705
Epoch 33: f= 1304.383, eps=0.000583353

Epoch 34: f= 1304.383, eps=0.000612520
Epoch 35: f= 1304.383, eps=0.000643146
Epoch 36: f= 1304.383, eps=0.000675303
Epoch 37: f= 1304.383, eps=0.000709069
Epoch 38: f= 1304.383, eps=0.000744522
Epoch 39: f= 1304.383, eps=0.000781748
Epoch 40: f= 1304.383, eps=0.000390874
Epoch 41: f= 1304.383, eps=0.000410418
Epoch 42: f= 1304.383, eps=0.000430939
Epoch 43: f= 1304.383, eps=0.000452486
Epoch 44: f= 1304.383, eps=0.000226243
Epoch 45: f= 1304.383, eps=0.000237555
Epoch 46: f= 1304.383, eps=0.000249433
Epoch 47: f= 1304.383, eps=0.000124716
Epoch 48: f= 1304.383, eps=0.000130952
Epoch 49: f= 1304.383, eps=0.000137500
Epoch 50: f= 1304.383, eps=0.000144375
Epoch 51: f= 1304.383, eps=0.000151594
Epoch 52: f= 1304.383, eps=0.000075797
Epoch 53: f= 1304.383, eps=0.000079587
Epoch 54: f= 1304.383, eps=0.000083566
Epoch 55: f= 1304.383, eps=0.000041783
Epoch 56: f= 1304.383, eps=0.000043872
Epoch 57: f= 1304.383, eps=0.000046066
Epoch 58: f= 1304.383, eps=0.000048369
Epoch 59: f= 1304.383, eps=0.000024184
Epoch 60: f= 1304.383, eps=0.000025394
Epoch 61: f= 1304.383, eps=0.000026663
Epoch 62: f= 1304.383, eps=0.000027997
Epoch 63: f= 1304.383, eps=0.000029396
Epoch 64: f= 1304.383, eps=0.000030866
Epoch 65: f= 1304.383, eps=0.000032410
Epoch 66: f= 1304.383, eps=0.000034030
Epoch 67: f= 1304.383, eps=0.000035732
Epoch 68: f= 1304.383, eps=0.000037518
Epoch 69: f= 1304.383, eps=0.000039394
Epoch 70: f= 1304.383, eps=0.000041364
Epoch 71: f= 1304.383, eps=0.000043432
Epoch 72: f= 1304.383, eps=0.000021716
Epoch 73: f= 1304.383, eps=0.000022802
Epoch 74: f= 1304.383, eps=0.000023942
Epoch 75: f= 1304.383, eps=0.000011971
Epoch 76: f= 1304.383, eps=0.000012569
Epoch 77: f= 1304.383, eps=0.000013198
Epoch 78: f= 1304.383, eps=0.000013858
Epoch 79: f= 1304.383, eps=0.000014551
Epoch 80: f= 1304.383, eps=0.000015278
Epoch 81: f= 1304.383, eps=0.000016042

Epoch 82: f= 1304.383, eps=0.000016844
Epoch 83: f= 1304.383, eps=0.000017686
Epoch 84: f= 1304.383, eps=0.000018571
Epoch 85: f= 1304.383, eps=0.000019499
Epoch 86: f= 1304.383, eps=0.000020474
Epoch 87: f= 1304.383, eps=0.000021498
Epoch 88: f= 1304.383, eps=0.000022573
Epoch 89: f= 1304.383, eps=0.000023702
Epoch 90: f= 1304.383, eps=0.000024887
Epoch 91: f= 1304.383, eps=0.000026131
Epoch 92: f= 1304.383, eps=0.000027438
Epoch 93: f= 1304.383, eps=0.000028809
Epoch 94: f= 1304.383, eps=0.000030250
Epoch 95: f= 1304.383, eps=0.000031762
Epoch 96: f= 1304.383, eps=0.000033351
Epoch 97: f= 1304.383, eps=0.000035018
Epoch 98: f= 1304.383, eps=0.000017509
Epoch 99: f= 1304.383, eps=0.000018384
Epoch 100: f= 1304.383, eps=0.000009192
Epoch 101: f= 1304.383, eps=0.000009652
Epoch 102: f= 1304.383, eps=0.000010134
Epoch 103: f= 1304.383, eps=0.000010641
Epoch 104: f= 1304.383, eps=0.000011173
Epoch 105: f= 1304.383, eps=0.000011732
Epoch 106: f= 1304.383, eps=0.000012318
Epoch 107: f= 1304.383, eps=0.000012934
Epoch 108: f= 1304.383, eps=0.000013581
Epoch 109: f= 1304.383, eps=0.000006791
Epoch 110: f= 1304.383, eps=0.000007130
Epoch 111: f= 1304.383, eps=0.000007487
Epoch 112: f= 1304.383, eps=0.000007861
Epoch 113: f= 1304.383, eps=0.000008254
Epoch 114: f= 1304.383, eps=0.000008667
Epoch 115: f= 1304.383, eps=0.000009100
Epoch 116: f= 1304.383, eps=0.000009555
Epoch 117: f= 1304.383, eps=0.000010033
Epoch 118: f= 1304.383, eps=0.000010534
Epoch 119: f= 1304.383, eps=0.000011061
Epoch 120: f= 1304.383, eps=0.000011614
Epoch 121: f= 1304.383, eps=0.000012195
Epoch 122: f= 1304.383, eps=0.000012805
Epoch 123: f= 1304.383, eps=0.000013445
Epoch 124: f= 1304.383, eps=0.000006722
Epoch 125: f= 1304.383, eps=0.000007059
Epoch 126: f= 1304.383, eps=0.000007411
Epoch 127: f= 1304.383, eps=0.000007782
Epoch 128: f= 1304.383, eps=0.000008171
Epoch 129: f= 1304.383, eps=0.000008580

Epoch 130: f= 1304.383, eps=0.000009009
Epoch 131: f= 1304.383, eps=0.000009459
Epoch 132: f= 1304.383, eps=0.000009932
Epoch 133: f= 1304.383, eps=0.000010429
Epoch 134: f= 1304.383, eps=0.000010950
Epoch 135: f= 1304.383, eps=0.000011498
Epoch 136: f= 1304.383, eps=0.000012073
Epoch 137: f= 1304.383, eps=0.000012676
Epoch 138: f= 1304.383, eps=0.000013310
Epoch 139: f= 1304.383, eps=0.000013975
Epoch 140: f= 1304.383, eps=0.000014674
Epoch 141: f= 1304.383, eps=0.000015408
Epoch 142: f= 1304.383, eps=0.000016178
Epoch 143: f= 1304.383, eps=0.000016987
Epoch 144: f= 1304.383, eps=0.000008494
Epoch 145: f= 1304.383, eps=0.000008918
Epoch 146: f= 1304.383, eps=0.000009364
Epoch 147: f= 1304.383, eps=0.000009832
Epoch 148: f= 1304.383, eps=0.000010324
Epoch 149: f= 1304.383, eps=0.000010840
Epoch 150: f= 1304.383, eps=0.000011382
Epoch 151: f= 1304.383, eps=0.000011951
Epoch 152: f= 1304.383, eps=0.000012549
Epoch 153: f= 1304.383, eps=0.000013176
Epoch 154: f= 1304.383, eps=0.000013835
Epoch 155: f= 1304.383, eps=0.000014527
Epoch 156: f= 1304.383, eps=0.000015253
Epoch 157: f= 1304.383, eps=0.000016016
Epoch 158: f= 1304.383, eps=0.000016817
Epoch 159: f= 1304.383, eps=0.000008408
Epoch 160: f= 1304.383, eps=0.000008829
Epoch 161: f= 1304.383, eps=0.000009270
Epoch 162: f= 1304.383, eps=0.000009734
Epoch 163: f= 1304.383, eps=0.000004867
Epoch 164: f= 1304.383, eps=0.000005110
Epoch 165: f= 1304.383, eps=0.000005366
Epoch 166: f= 1304.383, eps=0.000002683
Epoch 167: f= 1304.383, eps=0.000002817
Epoch 168: f= 1304.383, eps=0.000002958
Epoch 169: f= 1304.383, eps=0.000003106
Epoch 170: f= 1304.383, eps=0.000003261
Epoch 171: f= 1304.383, eps=0.000003424
Epoch 172: f= 1304.383, eps=0.000003595
Epoch 173: f= 1304.383, eps=0.000003775
Epoch 174: f= 1304.383, eps=0.000003964
Epoch 175: f= 1304.383, eps=0.000004162
Epoch 176: f= 1304.383, eps=0.000004370
Epoch 177: f= 1304.383, eps=0.000004589

Epoch 178: f= 1304.383, eps=0.000004818
Epoch 179: f= 1304.383, eps=0.000005059
Epoch 180: f= 1304.383, eps=0.000005312
Epoch 181: f= 1304.383, eps=0.000005577
Epoch 182: f= 1304.383, eps=0.000005856
Epoch 183: f= 1304.383, eps=0.000002928
Epoch 184: f= 1304.383, eps=0.000003075
Epoch 185: f= 1304.383, eps=0.000003228
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Epoch 193: f= 1304.383, eps=0.000002271
Epoch 194: f= 1304.383, eps=0.000002385
Epoch 195: f= 1304.383, eps=0.000002504
Epoch 196: f= 1304.383, eps=0.000002629
Epoch 197: f= 1304.383, eps=0.000002761
Epoch 198: f= 1304.383, eps=0.000002899
Epoch 199: f= 1304.383, eps=0.000003044
Epoch 200: f= 1304.383, eps=0.000003196
Epoch 201: f= 1304.383, eps=0.000003356
Epoch 202: f= 1304.383, eps=0.000003524
Epoch 203: f= 1304.383, eps=0.000003700
Epoch 204: f= 1304.383, eps=0.000003885
Epoch 205: f= 1304.383, eps=0.000004079
Epoch 206: f= 1304.383, eps=0.000004283
Epoch 207: f= 1304.383, eps=0.000004497
Epoch 208: f= 1304.383, eps=0.000004722
Epoch 209: f= 1304.383, eps=0.000002361
Epoch 210: f= 1304.383, eps=0.000002479
Epoch 211: f= 1304.383, eps=0.000002603
Epoch 212: f= 1304.383, eps=0.000002733
Epoch 213: f= 1304.383, eps=0.000002870
Epoch 214: f= 1304.383, eps=0.000003013
Epoch 215: f= 1304.383, eps=0.000003164
Epoch 216: f= 1304.383, eps=0.000003322
Epoch 217: f= 1304.383, eps=0.000003488
Epoch 218: f= 1304.383, eps=0.000003663
Epoch 219: f= 1304.383, eps=0.000001831
Epoch 220: f= 1304.383, eps=0.000001923
Epoch 221: f= 1304.383, eps=0.000002019
Epoch 222: f= 1304.383, eps=0.000002120
Epoch 223: f= 1304.383, eps=0.000002226
Epoch 224: f= 1304.383, eps=0.000002337
Epoch 225: f= 1304.383, eps=0.000002454

Epoch 226: f= 1304.383, eps=0.000002577
Epoch 227: f= 1304.383, eps=0.000002706
Epoch 228: f= 1304.383, eps=0.000002841
Epoch 229: f= 1304.383, eps=0.000002983
Epoch 230: f= 1304.383, eps=0.000003132
Epoch 231: f= 1304.383, eps=0.000003289
Epoch 232: f= 1304.383, eps=0.000003453
Epoch 233: f= 1304.383, eps=0.000003626
Epoch 234: f= 1304.383, eps=0.000003807
Epoch 235: f= 1304.383, eps=0.000003997
Epoch 236: f= 1304.383, eps=0.000004197
Epoch 237: f= 1304.383, eps=0.000004407
Epoch 238: f= 1304.383, eps=0.000004628
Epoch 239: f= 1304.383, eps=0.000004859
Epoch 240: f= 1304.383, eps=0.000005102
Epoch 241: f= 1304.383, eps=0.000005357
Epoch 242: f= 1304.383, eps=0.000005625
Epoch 243: f= 1304.383, eps=0.000005906
Epoch 244: f= 1304.383, eps=0.000006201
Epoch 245: f= 1304.383, eps=0.000006511
Epoch 246: f= 1304.383, eps=0.000006837
Epoch 247: f= 1304.383, eps=0.000007179
Epoch 248: f= 1304.383, eps=0.000003589
Epoch 249: f= 1304.383, eps=0.000003769
Epoch 250: f= 1304.383, eps=0.000001884
Epoch 251: f= 1304.383, eps=0.000001979
Epoch 252: f= 1304.383, eps=0.000002078
Epoch 253: f= 1304.383, eps=0.000002181
Epoch 254: f= 1304.383, eps=0.000001091
Epoch 255: f= 1304.383, eps=0.000001145
Epoch 256: f= 1304.383, eps=0.000000573
Epoch 257: f= 1304.383, eps=0.000000601
Epoch 258: f= 1304.383, eps=0.000000631
Epoch 259: f= 1304.383, eps=0.000000663
Epoch 260: f= 1304.383, eps=0.000000696
Epoch 261: f= 1304.383, eps=0.000000731
Epoch 262: f= 1304.383, eps=0.000000767
Epoch 263: f= 1304.383, eps=0.000000806
Epoch 264: f= 1304.383, eps=0.000000403
Epoch 265: f= 1304.383, eps=0.000000423
Epoch 266: f= 1304.383, eps=0.000000444
Epoch 267: f= 1304.383, eps=0.000000466
Epoch 268: f= 1304.383, eps=0.000000490
Epoch 269: f= 1304.383, eps=0.000000514
Epoch 270: f= 1304.383, eps=0.000000540
Epoch 271: f= 1304.383, eps=0.000000567
Epoch 272: f= 1304.383, eps=0.000000595
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Lambda = 500: Final Objective = 0.0000

[319]: results

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[320]: train_nll = {}
for k, v in results.items():
    print("lambda " + k + ": " + str(v["final_nll_values"][-1]))
    train_nll[k] = v["final_nll_values"][-1]

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lambda 0: 655.413496469947
lambda 0.01: 656.1869767255795
lambda 0.1: 661.3584589394447
lambda 0.5: 674.1008281100459
lambda 1: 682.8492956819674
lambda 2: 695.3995518029757
lambda 3: 705.5283790137129
lambda 4: 714.3804990993457
lambda 5: 722.3720587338794
lambda 10: 754.8524204027967
lambda 20: 801.9128109439285
lambda 100: 988.511839602703
lambda 200: 1108.9460399053748
lambda 500: 1304.383410297585

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[321]: results

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[321]: {'0': {'final_weights': array([-8.86805803e-03, -1.87711722e-01,
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[illegible]

[illegible]

[illegible]

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[illegible]

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```
[322]: lambdas = list(train_nll.keys())

# Extracting values for plotting
train_nll_values = [train_nll[lam] for lam in lambdas]
# Setting up the scatter plot
plt.figure(figsize=(10, 6))

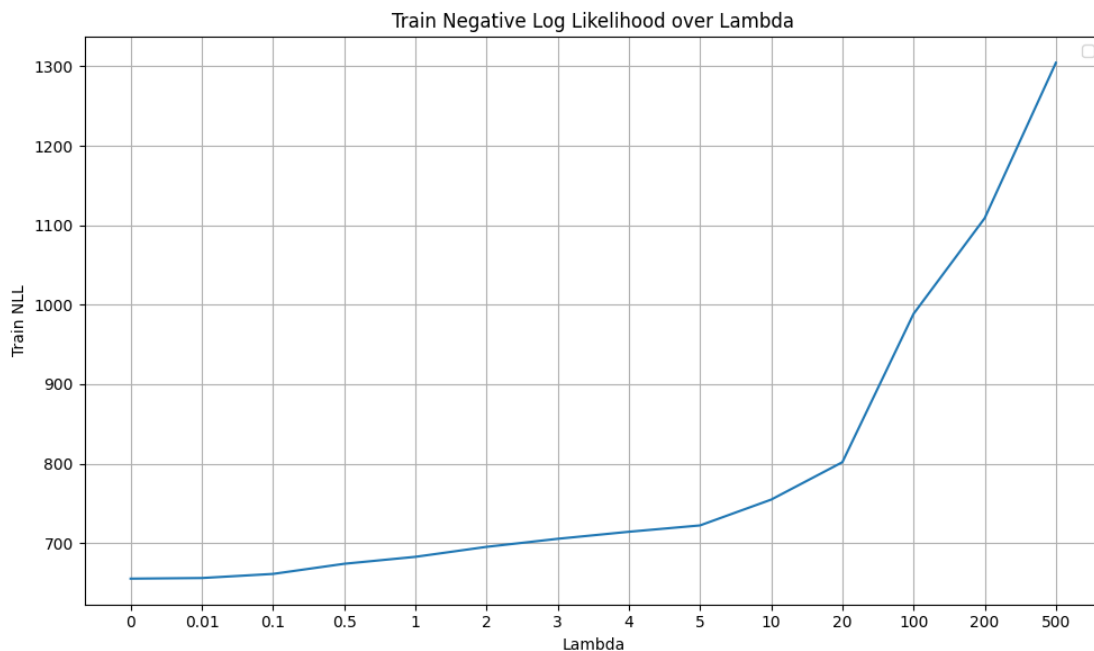
plt.plot(lambdas, train_nll_values)

# Adding labels and title
plt.xlabel('Lambda')
plt.ylabel('Train NLL')
plt.title('Train Negative Log Likelihood over Lambda')
plt.legend()
plt.grid(True)

# Show the plot
plt.tight_layout()
plt.show()
```

/tmp/ipykernel_32055/158038987.py:14: UserWarning: No artists with labels found to put in legend. Note that artists whose label start with an underscore are ignored when legend() is called with no argument.

```
plt.legend()
```



```

[323]: test_nll_results = {}
for lam in lam_values:
    np.random.seed(0) # Set a seed for reproducibility in weight initialization
    w0 = np.random.normal(size=D) # Initialize weights randomly

    # Optimize logistic regression with L2 regularization for the current lambda
    wz, vz, ez = optimize(gd_l2(ytest, Xtestz, lam), w0, nepochs=500)

    # Store final weights and objective value after training
    test_nll_results[str(lam)] = {
        'final_weights': wz, # Final weight vector after optimization
        'final_nll_values': vz,
        'final_objective': ez[-1] # Final value of the objective function
    }

# for la in lam_values:
#     print("lambda " + str(la) + ": " + str(-l_l2(ytest, Xtestz,
# ↪results[str(la)]["final_weights"], la)))
#     test_nll_results[la] = -l_l2(ytest, Xtestz,
# ↪results[str(la)]["final_weights"], la)

test_nll = {}
for k, v in test_nll_results.items():
    print("lambda " + k + ": " + str(v["final_nll_values"][-1]))
    test_nll[k] = v["final_nll_values"][-1]

```

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Epoch 141: f= 327.746, eps=0.005827714
Epoch 142: f= 327.694, eps=0.006119100
Epoch 143: f= 327.640, eps=0.006425055
Epoch 144: f= 327.584, eps=0.006746307
Epoch 145: f= 327.526, eps=0.007083623
Epoch 146: f= 327.465, eps=0.007437804
Epoch 147: f= 327.403, eps=0.007809694
Epoch 148: f= 327.338, eps=0.008200179
Epoch 149: f= 327.270, eps=0.008610188
Epoch 150: f= 327.201, eps=0.009040697
Epoch 151: f= 327.128, eps=0.009492732
Epoch 152: f= 327.054, eps=0.009967368
Epoch 153: f= 326.977, eps=0.010465737
Epoch 154: f= 326.904, eps=0.010989024
Epoch 155: f= 326.924, eps=0.005494512
Epoch 156: f= 327.016, eps=0.002747256
Epoch 157: f= 326.753, eps=0.002884619
Epoch 158: f= 326.731, eps=0.003028850
Epoch 159: f= 326.709, eps=0.003180292
Epoch 160: f= 326.686, eps=0.003339307
Epoch 161: f= 326.661, eps=0.003506272
Epoch 162: f= 326.636, eps=0.003681586
Epoch 163: f= 326.609, eps=0.003865665
Epoch 164: f= 326.582, eps=0.004058948

Epoch 165: f= 326.553, eps=0.004261896
Epoch 166: f= 326.522, eps=0.004474990
Epoch 167: f= 326.491, eps=0.004698740
Epoch 168: f= 326.458, eps=0.004933677
Epoch 169: f= 326.423, eps=0.005180361
Epoch 170: f= 326.387, eps=0.005439379
Epoch 171: f= 326.350, eps=0.005711348
Epoch 172: f= 326.311, eps=0.005996915
Epoch 173: f= 326.270, eps=0.006296761
Epoch 174: f= 326.228, eps=0.006611599
Epoch 175: f= 326.183, eps=0.006942179
Epoch 176: f= 326.137, eps=0.007289288
Epoch 177: f= 326.089, eps=0.007653752
Epoch 178: f= 326.039, eps=0.008036440
Epoch 179: f= 325.987, eps=0.008438262
Epoch 180: f= 325.933, eps=0.008860175
Epoch 181: f= 325.878, eps=0.009303184
Epoch 182: f= 325.834, eps=0.009768343
Epoch 183: f= 325.938, eps=0.004884171
Epoch 184: f= 326.012, eps=0.002442086
Epoch 185: f= 325.715, eps=0.002564190
Epoch 186: f= 325.695, eps=0.002692399
Epoch 187: f= 325.678, eps=0.002827019
Epoch 188: f= 325.661, eps=0.002968370
Epoch 189: f= 325.643, eps=0.003116789
Epoch 190: f= 325.624, eps=0.003272628
Epoch 191: f= 325.604, eps=0.003436260
Epoch 192: f= 325.583, eps=0.003608073
Epoch 193: f= 325.562, eps=0.003788476
Epoch 194: f= 325.539, eps=0.003977900
Epoch 195: f= 325.515, eps=0.004176795
Epoch 196: f= 325.490, eps=0.004385635
Epoch 197: f= 325.464, eps=0.004604917
Epoch 198: f= 325.437, eps=0.004835163
Epoch 199: f= 325.408, eps=0.005076921
Epoch 200: f= 325.378, eps=0.005330767
Epoch 201: f= 325.347, eps=0.005597305
Epoch 202: f= 325.315, eps=0.005877170
Epoch 203: f= 325.281, eps=0.006171029
Epoch 204: f= 325.245, eps=0.006479580
Epoch 205: f= 325.208, eps=0.006803559
Epoch 206: f= 325.170, eps=0.007143737
Epoch 207: f= 325.129, eps=0.007500924
Epoch 208: f= 325.087, eps=0.007875970
Epoch 209: f= 325.043, eps=0.008269769
Epoch 210: f= 324.997, eps=0.008683257
Epoch 211: f= 324.950, eps=0.009117420
Epoch 212: f= 324.900, eps=0.009573291

Epoch 213: f= 324.851, eps=0.010051956
Epoch 214: f= 324.830, eps=0.010554554
Epoch 215: f= 325.193, eps=0.005277277
Epoch 216: f= 325.121, eps=0.005541141
Epoch 217: f= 325.606, eps=0.002770570
Epoch 218: f= 324.689, eps=0.002909099
Epoch 219: f= 324.652, eps=0.003054554
Epoch 220: f= 324.635, eps=0.003207282
Epoch 221: f= 324.618, eps=0.003367646
Epoch 222: f= 324.601, eps=0.003536028
Epoch 223: f= 324.582, eps=0.003712829
Epoch 224: f= 324.563, eps=0.003898471
Epoch 225: f= 324.543, eps=0.004093394
Epoch 226: f= 324.522, eps=0.004298064
Epoch 227: f= 324.500, eps=0.004512967
Epoch 228: f= 324.477, eps=0.004738616
Epoch 229: f= 324.453, eps=0.004975546
Epoch 230: f= 324.427, eps=0.005224324
Epoch 231: f= 324.401, eps=0.005485540
Epoch 232: f= 324.373, eps=0.005759817
Epoch 233: f= 324.344, eps=0.006047808
Epoch 234: f= 324.314, eps=0.006350198
Epoch 235: f= 324.282, eps=0.006667708
Epoch 236: f= 324.250, eps=0.007001093
Epoch 237: f= 324.216, eps=0.007351148
Epoch 238: f= 324.182, eps=0.007718705
Epoch 239: f= 324.159, eps=0.008104641
Epoch 240: f= 324.225, eps=0.004052320
Epoch 241: f= 324.132, eps=0.004254936
Epoch 242: f= 324.109, eps=0.004467683
Epoch 243: f= 324.078, eps=0.004691067
Epoch 244: f= 324.067, eps=0.004925621
Epoch 245: f= 324.053, eps=0.005171902
Epoch 246: f= 324.080, eps=0.002585951
Epoch 247: f= 323.958, eps=0.002715248
Epoch 248: f= 323.945, eps=0.002851011
Epoch 249: f= 323.932, eps=0.002993561
Epoch 250: f= 323.917, eps=0.003143239
Epoch 251: f= 323.903, eps=0.003300401
Epoch 252: f= 323.887, eps=0.003465421
Epoch 253: f= 323.871, eps=0.003638693
Epoch 254: f= 323.854, eps=0.003820627
Epoch 255: f= 323.836, eps=0.004011659
Epoch 256: f= 323.818, eps=0.004212241
Epoch 257: f= 323.798, eps=0.004422854
Epoch 258: f= 323.778, eps=0.004643996
Epoch 259: f= 323.756, eps=0.004876196
Epoch 260: f= 323.734, eps=0.005120006

Epoch 261: f= 323.710, eps=0.005376006
Epoch 262: f= 323.686, eps=0.005644806
Epoch 263: f= 323.660, eps=0.005927047
Epoch 264: f= 323.633, eps=0.006223399
Epoch 265: f= 323.605, eps=0.006534569
Epoch 266: f= 323.576, eps=0.006861297
Epoch 267: f= 323.545, eps=0.007204362
Epoch 268: f= 323.513, eps=0.007564580
Epoch 269: f= 323.480, eps=0.007942809
Epoch 270: f= 323.445, eps=0.008339950
Epoch 271: f= 323.408, eps=0.008756947
Epoch 272: f= 323.371, eps=0.009194795
Epoch 273: f= 323.337, eps=0.009654535
Epoch 274: f= 323.363, eps=0.004827267
Epoch 275: f= 323.347, eps=0.005068631
Epoch 276: f= 323.389, eps=0.002534315
Epoch 277: f= 323.235, eps=0.002661031
Epoch 278: f= 323.224, eps=0.002794083
Epoch 279: f= 323.212, eps=0.002933787
Epoch 280: f= 323.200, eps=0.003080476
Epoch 281: f= 323.187, eps=0.003234500
Epoch 282: f= 323.173, eps=0.003396225
Epoch 283: f= 323.159, eps=0.003566036
Epoch 284: f= 323.144, eps=0.003744338
Epoch 285: f= 323.128, eps=0.003931555
Epoch 286: f= 323.111, eps=0.004128133
Epoch 287: f= 323.094, eps=0.004334539
Epoch 288: f= 323.076, eps=0.004551266
Epoch 289: f= 323.057, eps=0.004778830
Epoch 290: f= 323.037, eps=0.005017771
Epoch 291: f= 323.017, eps=0.005268660
Epoch 292: f= 322.995, eps=0.005532093
Epoch 293: f= 322.972, eps=0.005808697
Epoch 294: f= 322.948, eps=0.006099132
Epoch 295: f= 322.924, eps=0.006404089
Epoch 296: f= 322.897, eps=0.006724293
Epoch 297: f= 322.870, eps=0.007060508
Epoch 298: f= 322.842, eps=0.007413533
Epoch 299: f= 322.812, eps=0.007784210
Epoch 300: f= 322.781, eps=0.008173420
Epoch 301: f= 322.748, eps=0.008582091
Epoch 302: f= 322.714, eps=0.009011196
Epoch 303: f= 322.679, eps=0.009461756
Epoch 304: f= 322.642, eps=0.009934843
Epoch 305: f= 322.605, eps=0.010431585
Epoch 306: f= 322.595, eps=0.010953165
Epoch 307: f= 322.983, eps=0.005476582
Epoch 308: f= 323.017, eps=0.002738291

Epoch 309: f= 322.555, eps=0.002875206
Epoch 310: f= 322.481, eps=0.003018966
Epoch 311: f= 322.467, eps=0.003169914
Epoch 312: f= 322.455, eps=0.003328410
Epoch 313: f= 322.442, eps=0.003494831
Epoch 314: f= 322.429, eps=0.003669572
Epoch 315: f= 322.415, eps=0.003853051
Epoch 316: f= 322.400, eps=0.004045703
Epoch 317: f= 322.385, eps=0.004247988
Epoch 318: f= 322.369, eps=0.004460388
Epoch 319: f= 322.352, eps=0.004683407
Epoch 320: f= 322.335, eps=0.004917578
Epoch 321: f= 322.317, eps=0.005163456
Epoch 322: f= 322.298, eps=0.005421629
Epoch 323: f= 322.277, eps=0.005692711
Epoch 324: f= 322.256, eps=0.005977346
Epoch 325: f= 322.234, eps=0.006276214
Epoch 326: f= 322.212, eps=0.006590024
Epoch 327: f= 322.188, eps=0.006919525
Epoch 328: f= 322.164, eps=0.007265502
Epoch 329: f= 322.145, eps=0.007628777
Epoch 330: f= 322.162, eps=0.003814388
Epoch 331: f= 322.129, eps=0.004005108
Epoch 332: f= 322.098, eps=0.004205363
Epoch 333: f= 322.081, eps=0.004415631
Epoch 334: f= 322.064, eps=0.004636413
Epoch 335: f= 322.051, eps=0.004868234
Epoch 336: f= 322.039, eps=0.005111645
Epoch 337: f= 322.042, eps=0.002555823
Epoch 338: f= 321.989, eps=0.002683614
Epoch 339: f= 321.979, eps=0.002817794
Epoch 340: f= 321.969, eps=0.002958684
Epoch 341: f= 321.958, eps=0.003106618
Epoch 342: f= 321.948, eps=0.003261949
Epoch 343: f= 321.936, eps=0.003425047
Epoch 344: f= 321.924, eps=0.003596299
Epoch 345: f= 321.912, eps=0.003776114
Epoch 346: f= 321.898, eps=0.003964920
Epoch 347: f= 321.885, eps=0.004163166
Epoch 348: f= 321.870, eps=0.004371324
Epoch 349: f= 321.855, eps=0.004589890
Epoch 350: f= 321.839, eps=0.004819385
Epoch 351: f= 321.822, eps=0.005060354
Epoch 352: f= 321.805, eps=0.005313372
Epoch 353: f= 321.787, eps=0.005579040
Epoch 354: f= 321.768, eps=0.005857992
Epoch 355: f= 321.748, eps=0.006150892
Epoch 356: f= 321.727, eps=0.006458437

Epoch 357: f= 321.705, eps=0.006781358
Epoch 358: f= 321.682, eps=0.007120426
Epoch 359: f= 321.658, eps=0.007476448
Epoch 360: f= 321.633, eps=0.007850270
Epoch 361: f= 321.607, eps=0.008242783
Epoch 362: f= 321.580, eps=0.008654923
Epoch 363: f= 321.553, eps=0.009087669
Epoch 364: f= 321.545, eps=0.009542052
Epoch 365: f= 321.744, eps=0.004771026
Epoch 366: f= 321.677, eps=0.005009577
Epoch 367: f= 321.824, eps=0.002504789
Epoch 368: f= 321.453, eps=0.002630028
Epoch 369: f= 321.441, eps=0.002761530
Epoch 370: f= 321.432, eps=0.002899606
Epoch 371: f= 321.423, eps=0.003044586
Epoch 372: f= 321.413, eps=0.003196816
Epoch 373: f= 321.403, eps=0.003356656
Epoch 374: f= 321.392, eps=0.003524489
Epoch 375: f= 321.381, eps=0.003700714
Epoch 376: f= 321.369, eps=0.003885749
Epoch 377: f= 321.356, eps=0.004080037
Epoch 378: f= 321.343, eps=0.004284039
Epoch 379: f= 321.330, eps=0.004498241
Epoch 380: f= 321.316, eps=0.004723153
Epoch 381: f= 321.301, eps=0.004959310
Epoch 382: f= 321.285, eps=0.005207276
Epoch 383: f= 321.268, eps=0.005467640
Epoch 384: f= 321.251, eps=0.005741022
Epoch 385: f= 321.233, eps=0.006028073
Epoch 386: f= 321.214, eps=0.006329476
Epoch 387: f= 321.195, eps=0.006645950
Epoch 388: f= 321.174, eps=0.006978248
Epoch 389: f= 321.152, eps=0.007327160
Epoch 390: f= 321.130, eps=0.007693518
Epoch 391: f= 321.106, eps=0.008078194
Epoch 392: f= 321.082, eps=0.008482104
Epoch 393: f= 321.058, eps=0.008906209
Epoch 394: f= 321.054, eps=0.009351519
Epoch 395: f= 321.262, eps=0.004675760
Epoch 396: f= 321.370, eps=0.002337880
Epoch 397: f= 320.989, eps=0.002454774
Epoch 398: f= 320.972, eps=0.002577512
Epoch 399: f= 320.964, eps=0.002706388
Epoch 400: f= 320.956, eps=0.002841708
Epoch 401: f= 320.948, eps=0.002983793
Epoch 402: f= 320.939, eps=0.003132983
Epoch 403: f= 320.930, eps=0.003289632
Epoch 404: f= 320.920, eps=0.003454113

Epoch 405: f= 320.910, eps=0.003626819
Epoch 406: f= 320.899, eps=0.003808160
Epoch 407: f= 320.888, eps=0.003998568
Epoch 408: f= 320.876, eps=0.004198496
Epoch 409: f= 320.864, eps=0.004408421
Epoch 410: f= 320.851, eps=0.004628842
Epoch 411: f= 320.837, eps=0.004860284
Epoch 412: f= 320.823, eps=0.005103298
Epoch 413: f= 320.808, eps=0.005358463
Epoch 414: f= 320.792, eps=0.005626387
Epoch 415: f= 320.776, eps=0.005907706
Epoch 416: f= 320.759, eps=0.006203091
Epoch 417: f= 320.741, eps=0.006513246
Epoch 418: f= 320.722, eps=0.006838908
Epoch 419: f= 320.703, eps=0.007180853
Epoch 420: f= 320.682, eps=0.007539896
Epoch 421: f= 320.661, eps=0.007916891
Epoch 422: f= 320.639, eps=0.008312735
Epoch 423: f= 320.615, eps=0.008728372
Epoch 424: f= 320.591, eps=0.009164791
Epoch 425: f= 320.566, eps=0.009623030
Epoch 426: f= 320.548, eps=0.010104182
Epoch 427: f= 320.639, eps=0.005052091
Epoch 428: f= 320.658, eps=0.002526045
Epoch 429: f= 320.499, eps=0.002652348
Epoch 430: f= 320.483, eps=0.002784965
Epoch 431: f= 320.475, eps=0.002924213
Epoch 432: f= 320.467, eps=0.003070424
Epoch 433: f= 320.458, eps=0.003223945
Epoch 434: f= 320.449, eps=0.003385142
Epoch 435: f= 320.440, eps=0.003554400
Epoch 436: f= 320.430, eps=0.003732120
Epoch 437: f= 320.420, eps=0.003918726
Epoch 438: f= 320.410, eps=0.004114662
Epoch 439: f= 320.399, eps=0.004320395
Epoch 440: f= 320.387, eps=0.004536415
Epoch 441: f= 320.375, eps=0.004763235
Epoch 442: f= 320.362, eps=0.005001397
Epoch 443: f= 320.348, eps=0.005251467
Epoch 444: f= 320.334, eps=0.005514040
Epoch 445: f= 320.320, eps=0.005789742
Epoch 446: f= 320.304, eps=0.006079230
Epoch 447: f= 320.288, eps=0.006383191
Epoch 448: f= 320.271, eps=0.006702351
Epoch 449: f= 320.254, eps=0.007037468
Epoch 450: f= 320.235, eps=0.007389342
Epoch 451: f= 320.216, eps=0.007758809
Epoch 452: f= 320.196, eps=0.008146749

Epoch 453: f= 320.180, eps=0.008554086
Epoch 454: f= 320.200, eps=0.004277043
Epoch 455: f= 320.192, eps=0.004490895
Epoch 456: f= 320.176, eps=0.004715440
Epoch 457: f= 320.186, eps=0.002357720
Epoch 458: f= 320.112, eps=0.002475606
Epoch 459: f= 320.105, eps=0.002599386
Epoch 460: f= 320.099, eps=0.002729356
Epoch 461: f= 320.092, eps=0.002865824
Epoch 462: f= 320.084, eps=0.003009115
Epoch 463: f= 320.077, eps=0.003159570
Epoch 464: f= 320.069, eps=0.003317549
Epoch 465: f= 320.060, eps=0.003483426
Epoch 466: f= 320.051, eps=0.003657598
Epoch 467: f= 320.042, eps=0.003840478
Epoch 468: f= 320.033, eps=0.004032501
Epoch 469: f= 320.022, eps=0.004234127
Epoch 470: f= 320.012, eps=0.004445833
Epoch 471: f= 320.001, eps=0.004668125
Epoch 472: f= 319.989, eps=0.004901531
Epoch 473: f= 319.977, eps=0.005146607
Epoch 474: f= 319.964, eps=0.005403938
Epoch 475: f= 319.950, eps=0.005674135
Epoch 476: f= 319.936, eps=0.005957841
Epoch 477: f= 319.922, eps=0.006255733
Epoch 478: f= 319.906, eps=0.006568520
Epoch 479: f= 319.890, eps=0.006896946
Epoch 480: f= 319.873, eps=0.007241793
Epoch 481: f= 319.856, eps=0.007603883
Epoch 482: f= 319.837, eps=0.007984077
Epoch 483: f= 319.818, eps=0.008383281
Epoch 484: f= 319.798, eps=0.008802445
Epoch 485: f= 319.776, eps=0.009242567
Epoch 486: f= 319.754, eps=0.009704696
Epoch 487: f= 319.731, eps=0.010189930
Epoch 488: f= 319.708, eps=0.010699427
Epoch 489: f= 319.699, eps=0.011234398
Epoch 490: f= 319.942, eps=0.005617199
Epoch 491: f= 320.102, eps=0.002808600
Epoch 492: f= 319.709, eps=0.002949030
Epoch 493: f= 319.634, eps=0.003096481
Epoch 494: f= 319.623, eps=0.003251305
Epoch 495: f= 319.614, eps=0.003413870
Epoch 496: f= 319.606, eps=0.003584564
Epoch 497: f= 319.598, eps=0.003763792
Epoch 498: f= 319.589, eps=0.003951982
Epoch 499: f= 319.580, eps=0.004149581
Result after 500 epochs: f=319.5707412596371

Epoch	0:	f=	3403.852,	eps=0.010000000
Epoch	1:	f=	1331.988,	eps=0.010500000
Epoch	2:	f=	815.117,	eps=0.011025000
Epoch	3:	f=	591.649,	eps=0.011576250
Epoch	4:	f=	542.541,	eps=0.012155063
Epoch	5:	f=	478.372,	eps=0.012762816
Epoch	6:	f=	507.782,	eps=0.006381408
Epoch	7:	f=	428.537,	eps=0.006700478
Epoch	8:	f=	399.056,	eps=0.007035502
Epoch	9:	f=	393.751,	eps=0.007387277
Epoch	10:	f=	393.231,	eps=0.007756641
Epoch	11:	f=	401.006,	eps=0.003878321
Epoch	12:	f=	380.182,	eps=0.004072237
Epoch	13:	f=	375.486,	eps=0.004275848
Epoch	14:	f=	373.767,	eps=0.004489641
Epoch	15:	f=	372.284,	eps=0.004714123
Epoch	16:	f=	370.875,	eps=0.004949829
Epoch	17:	f=	369.648,	eps=0.005197320
Epoch	18:	f=	368.528,	eps=0.005457186
Epoch	19:	f=	367.343,	eps=0.005730046
Epoch	20:	f=	366.827,	eps=0.006016548
Epoch	21:	f=	365.435,	eps=0.006317375
Epoch	22:	f=	366.364,	eps=0.003158688
Epoch	23:	f=	358.388,	eps=0.003316622
Epoch	24:	f=	357.624,	eps=0.003482453
Epoch	25:	f=	356.865,	eps=0.003656576
Epoch	26:	f=	356.097,	eps=0.003839405
Epoch	27:	f=	355.315,	eps=0.004031375
Epoch	28:	f=	354.524,	eps=0.004232944
Epoch	29:	f=	353.724,	eps=0.004444591
Epoch	30:	f=	352.946,	eps=0.004666820
Epoch	31:	f=	352.195,	eps=0.004900161
Epoch	32:	f=	351.667,	eps=0.005145169
Epoch	33:	f=	351.130,	eps=0.005402428
Epoch	34:	f=	351.489,	eps=0.002701214
Epoch	35:	f=	348.894,	eps=0.002836275
Epoch	36:	f=	348.381,	eps=0.002978088
Epoch	37:	f=	347.901,	eps=0.003126993
Epoch	38:	f=	347.410,	eps=0.003283342
Epoch	39:	f=	346.906,	eps=0.003447510
Epoch	40:	f=	346.387,	eps=0.003619885
Epoch	41:	f=	345.853,	eps=0.003800879
Epoch	42:	f=	345.305,	eps=0.003990923
Epoch	43:	f=	344.742,	eps=0.004190469
Epoch	44:	f=	344.165,	eps=0.004399993
Epoch	45:	f=	343.576,	eps=0.004619993
Epoch	46:	f=	342.973,	eps=0.004850992
Epoch	47:	f=	342.360,	eps=0.005093542

Epoch 48: f= 341.739, eps=0.005348219
 Epoch 49: f= 341.115, eps=0.005615630
 Epoch 50: f= 340.501, eps=0.005896411
 Epoch 51: f= 339.966, eps=0.006191232
 Epoch 52: f= 339.640, eps=0.006500794
 Epoch 53: f= 340.343, eps=0.003250397
 Epoch 54: f= 338.242, eps=0.003412917
 Epoch 55: f= 337.889, eps=0.003583562
 Epoch 56: f= 337.562, eps=0.003762741
 Epoch 57: f= 337.233, eps=0.003950878
 Epoch 58: f= 336.901, eps=0.004148421
 Epoch 59: f= 336.568, eps=0.004355843
 Epoch 60: f= 336.234, eps=0.004573635
 Epoch 61: f= 335.902, eps=0.004802316
 Epoch 62: f= 335.574, eps=0.005042432
 Epoch 63: f= 335.254, eps=0.005294554
 Epoch 64: f= 334.946, eps=0.005559282
 Epoch 65: f= 334.658, eps=0.005837246
 Epoch 66: f= 334.416, eps=0.006129108
 Epoch 67: f= 334.258, eps=0.006435563
 Epoch 68: f= 334.501, eps=0.003217782
 Epoch 69: f= 333.683, eps=0.003378671
 Epoch 70: f= 333.550, eps=0.003547604
 Epoch 71: f= 333.424, eps=0.003724984
 Epoch 72: f= 333.297, eps=0.003911234
 Epoch 73: f= 333.169, eps=0.004106795
 Epoch 74: f= 333.040, eps=0.004312135
 Epoch 75: f= 332.909, eps=0.004527742
 Epoch 76: f= 332.777, eps=0.004754129
 Epoch 77: f= 332.643, eps=0.004991835
 Epoch 78: f= 332.507, eps=0.005241427
 Epoch 79: f= 332.369, eps=0.005503499
 Epoch 80: f= 332.230, eps=0.005778674
 Epoch 81: f= 332.089, eps=0.006067607
 Epoch 82: f= 331.946, eps=0.006370988
 Epoch 83: f= 331.801, eps=0.006689537
 Epoch 84: f= 331.655, eps=0.007024014
 Epoch 85: f= 331.511, eps=0.007375214
 Epoch 86: f= 331.382, eps=0.007743975
 Epoch 87: f= 331.352, eps=0.008131174
 Epoch 88: f= 331.865, eps=0.004065587
 Epoch 89: f= 331.525, eps=0.004268866
 Epoch 90: f= 331.044, eps=0.004482310
 Epoch 91: f= 330.952, eps=0.004706425
 Epoch 92: f= 330.846, eps=0.004941746
 Epoch 93: f= 330.798, eps=0.005188834
 Epoch 94: f= 330.742, eps=0.005448275
 Epoch 95: f= 330.804, eps=0.002724138

Epoch 96: f= 330.443, eps=0.002860345
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 Epoch 98: f= 330.348, eps=0.003153530
 Epoch 99: f= 330.300, eps=0.003311206
 Epoch 100: f= 330.250, eps=0.003476767
 Epoch 101: f= 330.198, eps=0.003650605
 Epoch 102: f= 330.144, eps=0.003833135
 Epoch 103: f= 330.088, eps=0.004024792
 Epoch 104: f= 330.031, eps=0.004226032
 Epoch 105: f= 329.971, eps=0.004437333
 Epoch 106: f= 329.910, eps=0.004659200
 Epoch 107: f= 329.846, eps=0.004892160
 Epoch 108: f= 329.780, eps=0.005136768
 Epoch 109: f= 329.713, eps=0.005393606
 Epoch 110: f= 329.643, eps=0.005663287
 Epoch 111: f= 329.570, eps=0.005946451
 Epoch 112: f= 329.496, eps=0.006243773
 Epoch 113: f= 329.419, eps=0.006555962
 Epoch 114: f= 329.340, eps=0.006883760
 Epoch 115: f= 329.259, eps=0.007227948
 Epoch 116: f= 329.175, eps=0.007589346
 Epoch 117: f= 329.089, eps=0.007968813
 Epoch 118: f= 329.001, eps=0.008367254
 Epoch 119: f= 328.910, eps=0.008785616
 Epoch 120: f= 328.817, eps=0.009224897
 Epoch 121: f= 328.722, eps=0.009686142
 Epoch 122: f= 328.635, eps=0.010170449
 Epoch 123: f= 328.661, eps=0.005085225
 Epoch 124: f= 328.617, eps=0.005339486
 Epoch 125: f= 328.703, eps=0.002669743
 Epoch 126: f= 328.396, eps=0.002803230
 Epoch 127: f= 328.369, eps=0.002943392
 Epoch 128: f= 328.341, eps=0.003090561
 Epoch 129: f= 328.312, eps=0.003245089
 Epoch 130: f= 328.282, eps=0.003407344
 Epoch 131: f= 328.250, eps=0.003577711
 Epoch 132: f= 328.218, eps=0.003756596
 Epoch 133: f= 328.183, eps=0.003944426
 Epoch 134: f= 328.148, eps=0.004141647
 Epoch 135: f= 328.111, eps=0.004348730
 Epoch 136: f= 328.072, eps=0.004566166
 Epoch 137: f= 328.032, eps=0.004794475
 Epoch 138: f= 327.990, eps=0.005034198
 Epoch 139: f= 327.946, eps=0.005285908
 Epoch 140: f= 327.901, eps=0.005550204
 Epoch 141: f= 327.854, eps=0.005827714
 Epoch 142: f= 327.805, eps=0.006119100
 Epoch 143: f= 327.754, eps=0.006425055

Epoch 144: f= 327.701, eps=0.006746307
Epoch 145: f= 327.646, eps=0.007083623
Epoch 146: f= 327.589, eps=0.007437804
Epoch 147: f= 327.530, eps=0.007809694
Epoch 148: f= 327.468, eps=0.008200179
Epoch 149: f= 327.405, eps=0.008610188
Epoch 150: f= 327.339, eps=0.009040697
Epoch 151: f= 327.274, eps=0.009492732
Epoch 152: f= 327.240, eps=0.009967368
Epoch 153: f= 327.569, eps=0.004983684
Epoch 154: f= 327.808, eps=0.002491842
Epoch 155: f= 327.108, eps=0.002616434
Epoch 156: f= 327.054, eps=0.002747256
Epoch 157: f= 327.034, eps=0.002884619
Epoch 158: f= 327.013, eps=0.003028850
Epoch 159: f= 326.991, eps=0.003180292
Epoch 160: f= 326.969, eps=0.003339307
Epoch 161: f= 326.945, eps=0.003506272
Epoch 162: f= 326.921, eps=0.003681586
Epoch 163: f= 326.895, eps=0.003865665
Epoch 164: f= 326.868, eps=0.004058948
Epoch 165: f= 326.840, eps=0.004261896
Epoch 166: f= 326.811, eps=0.004474990
Epoch 167: f= 326.780, eps=0.004698740
Epoch 168: f= 326.748, eps=0.004933677
Epoch 169: f= 326.714, eps=0.005180361
Epoch 170: f= 326.680, eps=0.005439379
Epoch 171: f= 326.643, eps=0.005711348
Epoch 172: f= 326.605, eps=0.005996915
Epoch 173: f= 326.566, eps=0.006296761
Epoch 174: f= 326.524, eps=0.006611599
Epoch 175: f= 326.481, eps=0.006942179
Epoch 176: f= 326.437, eps=0.007289288
Epoch 177: f= 326.390, eps=0.007653752
Epoch 178: f= 326.341, eps=0.008036440
Epoch 179: f= 326.291, eps=0.008438262
Epoch 180: f= 326.238, eps=0.008860175
Epoch 181: f= 326.184, eps=0.009303184
Epoch 182: f= 326.131, eps=0.009768343
Epoch 183: f= 326.115, eps=0.010256760
Epoch 184: f= 326.575, eps=0.005128380
Epoch 185: f= 326.972, eps=0.002564190
Epoch 186: f= 326.019, eps=0.002692399
Epoch 187: f= 325.946, eps=0.002827019
Epoch 188: f= 325.928, eps=0.002968370
Epoch 189: f= 325.911, eps=0.003116789
Epoch 190: f= 325.892, eps=0.003272628
Epoch 191: f= 325.873, eps=0.003436260

Epoch 192: f= 325.853, eps=0.003608073
Epoch 193: f= 325.832, eps=0.003788476
Epoch 194: f= 325.810, eps=0.003977900
Epoch 195: f= 325.788, eps=0.004176795
Epoch 196: f= 325.764, eps=0.004385635
Epoch 197: f= 325.739, eps=0.004604917
Epoch 198: f= 325.712, eps=0.004835163
Epoch 199: f= 325.685, eps=0.005076921
Epoch 200: f= 325.656, eps=0.005330767
Epoch 201: f= 325.627, eps=0.005597305
Epoch 202: f= 325.595, eps=0.005877170
Epoch 203: f= 325.563, eps=0.006171029
Epoch 204: f= 325.529, eps=0.006479580
Epoch 205: f= 325.493, eps=0.006803559
Epoch 206: f= 325.456, eps=0.007143737
Epoch 207: f= 325.417, eps=0.007500924
Epoch 208: f= 325.377, eps=0.007875970
Epoch 209: f= 325.335, eps=0.008269769
Epoch 210: f= 325.292, eps=0.008683257
Epoch 211: f= 325.252, eps=0.009117420
Epoch 212: f= 325.267, eps=0.004558710
Epoch 213: f= 325.229, eps=0.004786646
Epoch 214: f= 325.228, eps=0.005025978
Epoch 215: f= 325.217, eps=0.005277277
Epoch 216: f= 325.285, eps=0.002638638
Epoch 217: f= 325.082, eps=0.002770570
Epoch 218: f= 325.068, eps=0.002909099
Epoch 219: f= 325.053, eps=0.003054554
Epoch 220: f= 325.037, eps=0.003207282
Epoch 221: f= 325.021, eps=0.003367646
Epoch 222: f= 325.004, eps=0.003536028
Epoch 223: f= 324.986, eps=0.003712829
Epoch 224: f= 324.967, eps=0.003898471
Epoch 225: f= 324.948, eps=0.004093394
Epoch 226: f= 324.927, eps=0.004298064
Epoch 227: f= 324.906, eps=0.004512967
Epoch 228: f= 324.883, eps=0.004738616
Epoch 229: f= 324.860, eps=0.004975546
Epoch 230: f= 324.835, eps=0.005224324
Epoch 231: f= 324.810, eps=0.005485540
Epoch 232: f= 324.783, eps=0.005759817
Epoch 233: f= 324.755, eps=0.006047808
Epoch 234: f= 324.725, eps=0.006350198
Epoch 235: f= 324.695, eps=0.006667708
Epoch 236: f= 324.663, eps=0.007001093
Epoch 237: f= 324.629, eps=0.007351148
Epoch 238: f= 324.594, eps=0.007718705
Epoch 239: f= 324.558, eps=0.008104641

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Epoch 241: f= 324.480, eps=0.008935366
Epoch 242: f= 324.438, eps=0.009382135
Epoch 243: f= 324.396, eps=0.009851241
Epoch 244: f= 324.365, eps=0.010343803
Epoch 245: f= 324.506, eps=0.005171902
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Epoch 247: f= 324.271, eps=0.002715248
Epoch 248: f= 324.255, eps=0.002851011
Epoch 249: f= 324.242, eps=0.002993561
Epoch 250: f= 324.229, eps=0.003143239
Epoch 251: f= 324.215, eps=0.003300401
Epoch 252: f= 324.200, eps=0.003465421
Epoch 253: f= 324.185, eps=0.003638693
Epoch 254: f= 324.169, eps=0.003820627
Epoch 255: f= 324.152, eps=0.004011659
Epoch 256: f= 324.134, eps=0.004212241
Epoch 257: f= 324.115, eps=0.004422854
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Epoch 259: f= 324.076, eps=0.004876196
Epoch 260: f= 324.054, eps=0.005120006
Epoch 261: f= 324.032, eps=0.005376006
Epoch 262: f= 324.009, eps=0.005644806
Epoch 263: f= 323.984, eps=0.005927047
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Epoch 267: f= 323.875, eps=0.007204362
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Epoch 274: f= 323.767, eps=0.004827267
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Epoch 290: f= 323.423, eps=0.005017771
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Epoch 292: f= 323.382, eps=0.005532093
Epoch 293: f= 323.361, eps=0.005808697
Epoch 294: f= 323.338, eps=0.006099132
Epoch 295: f= 323.314, eps=0.006404089
Epoch 296: f= 323.289, eps=0.006724293
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Epoch 299: f= 323.208, eps=0.007784210
Epoch 300: f= 323.178, eps=0.008173420
Epoch 301: f= 323.147, eps=0.008582091
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Epoch 304: f= 323.047, eps=0.009934843
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Epoch 306: f= 323.214, eps=0.005215793
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Epoch 308: f= 322.966, eps=0.002738291
Epoch 309: f= 322.933, eps=0.002875206
Epoch 310: f= 322.922, eps=0.003018966
Epoch 311: f= 322.911, eps=0.003169914
Epoch 312: f= 322.899, eps=0.003328410
Epoch 313: f= 322.887, eps=0.003494831
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Epoch 319: f= 322.802, eps=0.004683407
Epoch 320: f= 322.785, eps=0.004917578
Epoch 321: f= 322.767, eps=0.005163456
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Epoch 345: f= 322.362, eps=0.003776114
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Epoch 354: f= 322.225, eps=0.005857992
Epoch 355: f= 322.206, eps=0.006150892
Epoch 356: f= 322.187, eps=0.006458437
Epoch 357: f= 322.166, eps=0.006781358
Epoch 358: f= 322.144, eps=0.007120426
Epoch 359: f= 322.122, eps=0.007476448
Epoch 360: f= 322.098, eps=0.007850270
Epoch 361: f= 322.073, eps=0.008242783
Epoch 362: f= 322.047, eps=0.008654923
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Epoch 365: f= 321.962, eps=0.010019155
Epoch 366: f= 321.931, eps=0.010520113
Epoch 367: f= 321.900, eps=0.011046118
Epoch 368: f= 321.881, eps=0.011598424
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Epoch 379: f= 321.718, eps=0.004498241
Epoch 380: f= 321.705, eps=0.004723153
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Epoch 383: f= 321.661, eps=0.005467640

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Epoch 387: f= 321.593, eps=0.006645950
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Epoch 390: f= 321.552, eps=0.007693518
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Epoch 393: f= 321.522, eps=0.004241052
Epoch 394: f= 321.500, eps=0.004453104
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Epoch 396: f= 321.482, eps=0.004909548
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Epoch 398: f= 321.430, eps=0.002577512
Epoch 399: f= 321.423, eps=0.002706388
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Epoch 402: f= 321.399, eps=0.003132983
Epoch 403: f= 321.390, eps=0.003289632
Epoch 404: f= 321.381, eps=0.003454113
Epoch 405: f= 321.372, eps=0.003626819
Epoch 406: f= 321.362, eps=0.003808160
Epoch 407: f= 321.351, eps=0.003998568
Epoch 408: f= 321.340, eps=0.004198496
Epoch 409: f= 321.329, eps=0.004408421
Epoch 410: f= 321.317, eps=0.004628842
Epoch 411: f= 321.304, eps=0.004860284
Epoch 412: f= 321.291, eps=0.005103298
Epoch 413: f= 321.277, eps=0.005358463
Epoch 414: f= 321.262, eps=0.005626387
Epoch 415: f= 321.247, eps=0.005907706
Epoch 416: f= 321.231, eps=0.006203091
Epoch 417: f= 321.215, eps=0.006513246
Epoch 418: f= 321.197, eps=0.006838908
Epoch 419: f= 321.179, eps=0.007180853
Epoch 420: f= 321.160, eps=0.007539896
Epoch 421: f= 321.140, eps=0.007916891
Epoch 422: f= 321.119, eps=0.008312735
Epoch 423: f= 321.097, eps=0.008728372
Epoch 424: f= 321.074, eps=0.009164791
Epoch 425: f= 321.052, eps=0.009623030
Epoch 426: f= 321.038, eps=0.010104182
Epoch 427: f= 321.157, eps=0.005052091
Epoch 428: f= 321.177, eps=0.002526045
Epoch 429: f= 320.992, eps=0.002652348
Epoch 430: f= 320.974, eps=0.002784965
Epoch 431: f= 320.966, eps=0.002924213

Epoch 432: f= 320.959, eps=0.003070424
Epoch 433: f= 320.951, eps=0.003223945
Epoch 434: f= 320.943, eps=0.003385142
Epoch 435: f= 320.934, eps=0.003554400
Epoch 436: f= 320.925, eps=0.003732120
Epoch 437: f= 320.916, eps=0.003918726
Epoch 438: f= 320.906, eps=0.004114662
Epoch 439: f= 320.896, eps=0.004320395
Epoch 440: f= 320.885, eps=0.004536415
Epoch 441: f= 320.874, eps=0.004763235
Epoch 442: f= 320.862, eps=0.005001397
Epoch 443: f= 320.849, eps=0.005251467
Epoch 444: f= 320.836, eps=0.005514040
Epoch 445: f= 320.823, eps=0.005789742
Epoch 446: f= 320.808, eps=0.006079230
Epoch 447: f= 320.793, eps=0.006383191
Epoch 448: f= 320.778, eps=0.006702351
Epoch 449: f= 320.761, eps=0.007037468
Epoch 450: f= 320.744, eps=0.007389342
Epoch 451: f= 320.726, eps=0.007758809
Epoch 452: f= 320.708, eps=0.008146749
Epoch 453: f= 320.694, eps=0.008554086
Epoch 454: f= 320.720, eps=0.004277043
Epoch 455: f= 320.713, eps=0.004490895
Epoch 456: f= 320.696, eps=0.004715440
Epoch 457: f= 320.709, eps=0.002357720
Epoch 458: f= 320.630, eps=0.002475606
Epoch 459: f= 320.624, eps=0.002599386
Epoch 460: f= 320.617, eps=0.002729356
Epoch 461: f= 320.611, eps=0.002865824
Epoch 462: f= 320.604, eps=0.003009115
Epoch 463: f= 320.597, eps=0.003159570
Epoch 464: f= 320.590, eps=0.003317549
Epoch 465: f= 320.582, eps=0.003483426
Epoch 466: f= 320.574, eps=0.003657598
Epoch 467: f= 320.565, eps=0.003840478
Epoch 468: f= 320.556, eps=0.004032501
Epoch 469: f= 320.547, eps=0.004234127
Epoch 470: f= 320.537, eps=0.004445833
Epoch 471: f= 320.527, eps=0.004668125
Epoch 472: f= 320.516, eps=0.004901531
Epoch 473: f= 320.505, eps=0.005146607
Epoch 474: f= 320.493, eps=0.005403938
Epoch 475: f= 320.480, eps=0.005674135
Epoch 476: f= 320.467, eps=0.005957841
Epoch 477: f= 320.454, eps=0.006255733
Epoch 478: f= 320.439, eps=0.006568520
Epoch 479: f= 320.424, eps=0.006896946

Epoch 480: f= 320.409, eps=0.007241793
 Epoch 481: f= 320.392, eps=0.007603883
 Epoch 482: f= 320.375, eps=0.007984077
 Epoch 483: f= 320.358, eps=0.008383281
 Epoch 484: f= 320.339, eps=0.008802445
 Epoch 485: f= 320.319, eps=0.009242567
 Epoch 486: f= 320.299, eps=0.009704696
 Epoch 487: f= 320.278, eps=0.010189930
 Epoch 488: f= 320.258, eps=0.010699427
 Epoch 489: f= 320.275, eps=0.005349713
 Epoch 490: f= 320.319, eps=0.002674857
 Epoch 491: f= 320.216, eps=0.002808600
 Epoch 492: f= 320.209, eps=0.002949030
 Epoch 493: f= 320.202, eps=0.003096481
 Epoch 494: f= 320.196, eps=0.003251305
 Epoch 495: f= 320.189, eps=0.003413870
 Epoch 496: f= 320.181, eps=0.003584564
 Epoch 497: f= 320.174, eps=0.003763792
 Epoch 498: f= 320.166, eps=0.003951982
 Epoch 499: f= 320.157, eps=0.004149581
 Result after 500 epochs: f=320.1482561851763
 Epoch 0: f= 3406.872, eps=0.010000000
 Epoch 1: f= 1336.651, eps=0.010500000
 Epoch 2: f= 818.017, eps=0.011025000
 Epoch 3: f= 594.169, eps=0.011576250
 Epoch 4: f= 545.052, eps=0.012155063
 Epoch 5: f= 481.039, eps=0.012762816
 Epoch 6: f= 510.863, eps=0.006381408
 Epoch 7: f= 430.499, eps=0.006700478
 Epoch 8: f= 400.757, eps=0.007035502
 Epoch 9: f= 395.242, eps=0.007387277
 Epoch 10: f= 394.469, eps=0.007756641
 Epoch 11: f= 402.487, eps=0.003878321
 Epoch 12: f= 381.671, eps=0.004072237
 Epoch 13: f= 377.206, eps=0.004275848
 Epoch 14: f= 375.472, eps=0.004489641
 Epoch 15: f= 373.954, eps=0.004714123
 Epoch 16: f= 372.547, eps=0.004949829
 Epoch 17: f= 371.279, eps=0.005197320
 Epoch 18: f= 370.187, eps=0.005457186
 Epoch 19: f= 368.944, eps=0.005730046
 Epoch 20: f= 368.487, eps=0.006016548
 Epoch 21: f= 367.012, eps=0.006317375
 Epoch 22: f= 368.054, eps=0.003158688
 Epoch 23: f= 359.953, eps=0.003316622
 Epoch 24: f= 359.177, eps=0.003482453
 Epoch 25: f= 358.409, eps=0.003656576
 Epoch 26: f= 357.635, eps=0.003839405

Epoch	27:	f=	356.846,	eps=0.004031375
Epoch	28:	f=	356.053,	eps=0.004232944
Epoch	29:	f=	355.252,	eps=0.004444591
Epoch	30:	f=	354.487,	eps=0.004666820
Epoch	31:	f=	353.756,	eps=0.004900161
Epoch	32:	f=	353.304,	eps=0.005145169
Epoch	33:	f=	352.751,	eps=0.005402428
Epoch	34:	f=	353.174,	eps=0.002701214
Epoch	35:	f=	350.391,	eps=0.002836275
Epoch	36:	f=	349.866,	eps=0.002978088
Epoch	37:	f=	349.385,	eps=0.003126993
Epoch	38:	f=	348.895,	eps=0.003283342
Epoch	39:	f=	348.392,	eps=0.003447510
Epoch	40:	f=	347.875,	eps=0.003619885
Epoch	41:	f=	347.345,	eps=0.003800879
Epoch	42:	f=	346.800,	eps=0.003990923
Epoch	43:	f=	346.242,	eps=0.004190469
Epoch	44:	f=	345.671,	eps=0.004399993
Epoch	45:	f=	345.088,	eps=0.004619993
Epoch	46:	f=	344.494,	eps=0.004850992
Epoch	47:	f=	343.892,	eps=0.005093542
Epoch	48:	f=	343.283,	eps=0.005348219
Epoch	49:	f=	342.677,	eps=0.005615630
Epoch	50:	f=	342.095,	eps=0.005896411
Epoch	51:	f=	341.640,	eps=0.006191232
Epoch	52:	f=	341.462,	eps=0.006500794
Epoch	53:	f=	342.631,	eps=0.003250397
Epoch	54:	f=	339.944,	eps=0.003412917
Epoch	55:	f=	339.554,	eps=0.003583562
Epoch	56:	f=	339.237,	eps=0.003762741
Epoch	57:	f=	338.921,	eps=0.003950878
Epoch	58:	f=	338.608,	eps=0.004148421
Epoch	59:	f=	338.294,	eps=0.004355843
Epoch	60:	f=	337.983,	eps=0.004573635
Epoch	61:	f=	337.676,	eps=0.004802316
Epoch	62:	f=	337.377,	eps=0.005042432
Epoch	63:	f=	337.089,	eps=0.005294554
Epoch	64:	f=	336.824,	eps=0.005559282
Epoch	65:	f=	336.592,	eps=0.005837246
Epoch	66:	f=	336.487,	eps=0.006129108
Epoch	67:	f=	336.502,	eps=0.003064554
Epoch	68:	f=	336.028,	eps=0.003217782
Epoch	69:	f=	335.777,	eps=0.003378671
Epoch	70:	f=	335.651,	eps=0.003547604
Epoch	71:	f=	335.530,	eps=0.003724984
Epoch	72:	f=	335.409,	eps=0.003911234
Epoch	73:	f=	335.287,	eps=0.004106795
Epoch	74:	f=	335.165,	eps=0.004312135

Epoch	75:	f=	335.041,	eps=0.004527742
Epoch	76:	f=	334.915,	eps=0.004754129
Epoch	77:	f=	334.789,	eps=0.004991835
Epoch	78:	f=	334.661,	eps=0.005241427
Epoch	79:	f=	334.531,	eps=0.005503499
Epoch	80:	f=	334.401,	eps=0.005778674
Epoch	81:	f=	334.270,	eps=0.006067607
Epoch	82:	f=	334.142,	eps=0.006370988
Epoch	83:	f=	334.026,	eps=0.006689537
Epoch	84:	f=	333.971,	eps=0.007024014
Epoch	85:	f=	334.111,	eps=0.003512007
Epoch	86:	f=	333.816,	eps=0.003687607
Epoch	87:	f=	333.611,	eps=0.003871988
Epoch	88:	f=	333.527,	eps=0.004065587
Epoch	89:	f=	333.449,	eps=0.004268866
Epoch	90:	f=	333.372,	eps=0.004482310
Epoch	91:	f=	333.295,	eps=0.004706425
Epoch	92:	f=	333.217,	eps=0.004941746
Epoch	93:	f=	333.137,	eps=0.005188834
Epoch	94:	f=	333.057,	eps=0.005448275
Epoch	95:	f=	332.979,	eps=0.005720689
Epoch	96:	f=	332.910,	eps=0.006006724
Epoch	97:	f=	332.868,	eps=0.006307060
Epoch	98:	f=	332.926,	eps=0.003153530
Epoch	99:	f=	332.683,	eps=0.003311206
Epoch	100:	f=	332.611,	eps=0.003476767
Epoch	101:	f=	332.561,	eps=0.003650605
Epoch	102:	f=	332.511,	eps=0.003833135
Epoch	103:	f=	332.460,	eps=0.004024792
Epoch	104:	f=	332.408,	eps=0.004226032
Epoch	105:	f=	332.354,	eps=0.004437333
Epoch	106:	f=	332.298,	eps=0.004659200
Epoch	107:	f=	332.240,	eps=0.004892160
Epoch	108:	f=	332.180,	eps=0.005136768
Epoch	109:	f=	332.119,	eps=0.005393606
Epoch	110:	f=	332.056,	eps=0.005663287
Epoch	111:	f=	331.991,	eps=0.005946451
Epoch	112:	f=	331.925,	eps=0.006243773
Epoch	113:	f=	331.858,	eps=0.006555962
Epoch	114:	f=	331.792,	eps=0.006883760
Epoch	115:	f=	331.741,	eps=0.007227948
Epoch	116:	f=	331.759,	eps=0.003613974
Epoch	117:	f=	331.654,	eps=0.003794673
Epoch	118:	f=	331.579,	eps=0.003984406
Epoch	119:	f=	331.533,	eps=0.004183627
Epoch	120:	f=	331.489,	eps=0.004392808
Epoch	121:	f=	331.446,	eps=0.004612449
Epoch	122:	f=	331.401,	eps=0.004843071

Epoch 123: f= 331.357, eps=0.005085225
Epoch 124: f= 331.312, eps=0.005339486
Epoch 125: f= 331.270, eps=0.005606460
Epoch 126: f= 331.232, eps=0.005886783
Epoch 127: f= 331.220, eps=0.006181122
Epoch 128: f= 331.263, eps=0.003090561
Epoch 129: f= 331.106, eps=0.003245089
Epoch 130: f= 331.049, eps=0.003407344
Epoch 131: f= 331.018, eps=0.003577711
Epoch 132: f= 330.987, eps=0.003756596
Epoch 133: f= 330.956, eps=0.003944426
Epoch 134: f= 330.923, eps=0.004141647
Epoch 135: f= 330.889, eps=0.004348730
Epoch 136: f= 330.854, eps=0.004566166
Epoch 137: f= 330.818, eps=0.004794475
Epoch 138: f= 330.780, eps=0.005034198
Epoch 139: f= 330.741, eps=0.005285908
Epoch 140: f= 330.700, eps=0.005550204
Epoch 141: f= 330.658, eps=0.005827714
Epoch 142: f= 330.614, eps=0.006119100
Epoch 143: f= 330.569, eps=0.006425055
Epoch 144: f= 330.524, eps=0.006746307
Epoch 145: f= 330.484, eps=0.007083623
Epoch 146: f= 330.472, eps=0.007437804
Epoch 147: f= 330.628, eps=0.003718902
Epoch 148: f= 330.384, eps=0.003904847
Epoch 149: f= 330.340, eps=0.004100089
Epoch 150: f= 330.300, eps=0.004305094
Epoch 151: f= 330.269, eps=0.004520348
Epoch 152: f= 330.237, eps=0.004746366
Epoch 153: f= 330.208, eps=0.004983684
Epoch 154: f= 330.178, eps=0.005232868
Epoch 155: f= 330.154, eps=0.005494512
Epoch 156: f= 330.137, eps=0.005769237
Epoch 157: f= 330.162, eps=0.002884619
Epoch 158: f= 330.041, eps=0.003028850
Epoch 159: f= 330.020, eps=0.003180292
Epoch 160: f= 330.000, eps=0.003339307
Epoch 161: f= 329.979, eps=0.003506272
Epoch 162: f= 329.957, eps=0.003681586
Epoch 163: f= 329.934, eps=0.003865665
Epoch 164: f= 329.910, eps=0.004058948
Epoch 165: f= 329.885, eps=0.004261896
Epoch 166: f= 329.860, eps=0.004474990
Epoch 167: f= 329.833, eps=0.004698740
Epoch 168: f= 329.805, eps=0.004933677
Epoch 169: f= 329.775, eps=0.005180361
Epoch 170: f= 329.745, eps=0.005439379

Epoch 171: f= 329.713, eps=0.005711348
Epoch 172: f= 329.680, eps=0.005996915
Epoch 173: f= 329.646, eps=0.006296761
Epoch 174: f= 329.610, eps=0.006611599
Epoch 175: f= 329.573, eps=0.006942179
Epoch 176: f= 329.534, eps=0.007289288
Epoch 177: f= 329.495, eps=0.007653752
Epoch 178: f= 329.457, eps=0.008036440
Epoch 179: f= 329.441, eps=0.008438262
Epoch 180: f= 329.591, eps=0.004219131
Epoch 181: f= 329.557, eps=0.004430087
Epoch 182: f= 329.427, eps=0.004651592
Epoch 183: f= 329.433, eps=0.002325796
Epoch 184: f= 329.284, eps=0.002442086
Epoch 185: f= 329.270, eps=0.002564190
Epoch 186: f= 329.257, eps=0.002692399
Epoch 187: f= 329.243, eps=0.002827019
Epoch 188: f= 329.228, eps=0.002968370
Epoch 189: f= 329.213, eps=0.003116789
Epoch 190: f= 329.197, eps=0.003272628
Epoch 191: f= 329.181, eps=0.003436260
Epoch 192: f= 329.164, eps=0.003608073
Epoch 193: f= 329.146, eps=0.003788476
Epoch 194: f= 329.127, eps=0.003977900
Epoch 195: f= 329.107, eps=0.004176795
Epoch 196: f= 329.087, eps=0.004385635
Epoch 197: f= 329.065, eps=0.004604917
Epoch 198: f= 329.043, eps=0.004835163
Epoch 199: f= 329.019, eps=0.005076921
Epoch 200: f= 328.995, eps=0.005330767
Epoch 201: f= 328.969, eps=0.005597305
Epoch 202: f= 328.943, eps=0.005877170
Epoch 203: f= 328.915, eps=0.006171029
Epoch 204: f= 328.886, eps=0.006479580
Epoch 205: f= 328.856, eps=0.006803559
Epoch 206: f= 328.825, eps=0.007143737
Epoch 207: f= 328.792, eps=0.007500924
Epoch 208: f= 328.758, eps=0.007875970
Epoch 209: f= 328.723, eps=0.008269769
Epoch 210: f= 328.686, eps=0.008683257
Epoch 211: f= 328.648, eps=0.009117420
Epoch 212: f= 328.608, eps=0.009573291
Epoch 213: f= 328.567, eps=0.010051956
Epoch 214: f= 328.524, eps=0.010554554
Epoch 215: f= 328.480, eps=0.011082281
Epoch 216: f= 328.443, eps=0.011636395
Epoch 217: f= 328.541, eps=0.005818198
Epoch 218: f= 328.779, eps=0.002909099

Epoch 219: f= 328.352, eps=0.003054554
Epoch 220: f= 328.338, eps=0.003207282
Epoch 221: f= 328.325, eps=0.003367646
Epoch 222: f= 328.312, eps=0.003536028
Epoch 223: f= 328.298, eps=0.003712829
Epoch 224: f= 328.283, eps=0.003898471
Epoch 225: f= 328.268, eps=0.004093394
Epoch 226: f= 328.251, eps=0.004298064
Epoch 227: f= 328.235, eps=0.004512967
Epoch 228: f= 328.217, eps=0.004738616
Epoch 229: f= 328.198, eps=0.004975546
Epoch 230: f= 328.179, eps=0.005224324
Epoch 231: f= 328.159, eps=0.005485540
Epoch 232: f= 328.138, eps=0.005759817
Epoch 233: f= 328.116, eps=0.006047808
Epoch 234: f= 328.093, eps=0.006350198
Epoch 235: f= 328.069, eps=0.006667708
Epoch 236: f= 328.045, eps=0.007001093
Epoch 237: f= 328.019, eps=0.007351148
Epoch 238: f= 327.992, eps=0.007718705
Epoch 239: f= 327.966, eps=0.008104641
Epoch 240: f= 327.954, eps=0.008509873
Epoch 241: f= 328.055, eps=0.004254936
Epoch 242: f= 328.039, eps=0.004467683
Epoch 243: f= 327.965, eps=0.004691067
Epoch 244: f= 327.983, eps=0.002345534
Epoch 245: f= 327.848, eps=0.002462810
Epoch 246: f= 327.839, eps=0.002585951
Epoch 247: f= 327.829, eps=0.002715248
Epoch 248: f= 327.820, eps=0.002851011
Epoch 249: f= 327.810, eps=0.002993561
Epoch 250: f= 327.800, eps=0.003143239
Epoch 251: f= 327.789, eps=0.003300401
Epoch 252: f= 327.777, eps=0.003465421
Epoch 253: f= 327.765, eps=0.003638693
Epoch 254: f= 327.753, eps=0.003820627
Epoch 255: f= 327.740, eps=0.004011659
Epoch 256: f= 327.726, eps=0.004212241
Epoch 257: f= 327.712, eps=0.004422854
Epoch 258: f= 327.697, eps=0.004643996
Epoch 259: f= 327.681, eps=0.004876196
Epoch 260: f= 327.665, eps=0.005120006
Epoch 261: f= 327.647, eps=0.005376006
Epoch 262: f= 327.630, eps=0.005644806
Epoch 263: f= 327.611, eps=0.005927047
Epoch 264: f= 327.591, eps=0.006223399
Epoch 265: f= 327.571, eps=0.006534569
Epoch 266: f= 327.550, eps=0.006861297

Epoch 267: f= 327.527, eps=0.007204362
Epoch 268: f= 327.504, eps=0.007564580
Epoch 269: f= 327.480, eps=0.007942809
Epoch 270: f= 327.455, eps=0.008339950
Epoch 271: f= 327.429, eps=0.008756947
Epoch 272: f= 327.401, eps=0.009194795
Epoch 273: f= 327.373, eps=0.009654535
Epoch 274: f= 327.343, eps=0.010137261
Epoch 275: f= 327.313, eps=0.010644124
Epoch 276: f= 327.290, eps=0.011176331
Epoch 277: f= 327.400, eps=0.005588165
Epoch 278: f= 327.482, eps=0.002794083
Epoch 279: f= 327.256, eps=0.002933787
Epoch 280: f= 327.215, eps=0.003080476
Epoch 281: f= 327.205, eps=0.003234500
Epoch 282: f= 327.195, eps=0.003396225
Epoch 283: f= 327.185, eps=0.003566036
Epoch 284: f= 327.175, eps=0.003744338
Epoch 285: f= 327.164, eps=0.003931555
Epoch 286: f= 327.152, eps=0.004128133
Epoch 287: f= 327.140, eps=0.004334539
Epoch 288: f= 327.128, eps=0.004551266
Epoch 289: f= 327.115, eps=0.004778830
Epoch 290: f= 327.101, eps=0.005017771
Epoch 291: f= 327.087, eps=0.005268660
Epoch 292: f= 327.072, eps=0.005532093
Epoch 293: f= 327.057, eps=0.005808697
Epoch 294: f= 327.040, eps=0.006099132
Epoch 295: f= 327.024, eps=0.006404089
Epoch 296: f= 327.006, eps=0.006724293
Epoch 297: f= 326.988, eps=0.007060508
Epoch 298: f= 326.971, eps=0.007413533
Epoch 299: f= 326.966, eps=0.007784210
Epoch 300: f= 327.035, eps=0.003892105
Epoch 301: f= 326.992, eps=0.004086710
Epoch 302: f= 326.942, eps=0.004291046
Epoch 303: f= 326.930, eps=0.004505598
Epoch 304: f= 326.913, eps=0.004730878
Epoch 305: f= 326.912, eps=0.004967422
Epoch 306: f= 326.910, eps=0.005215793
Epoch 307: f= 326.948, eps=0.002607896
Epoch 308: f= 326.836, eps=0.002738291
Epoch 309: f= 326.829, eps=0.002875206
Epoch 310: f= 326.821, eps=0.003018966
Epoch 311: f= 326.813, eps=0.003169914
Epoch 312: f= 326.805, eps=0.003328410
Epoch 313: f= 326.796, eps=0.003494831
Epoch 314: f= 326.787, eps=0.003669572

Epoch 315: f= 326.778, eps=0.003853051
Epoch 316: f= 326.768, eps=0.004045703
Epoch 317: f= 326.758, eps=0.004247988
Epoch 318: f= 326.747, eps=0.004460388
Epoch 319: f= 326.736, eps=0.004683407
Epoch 320: f= 326.724, eps=0.004917578
Epoch 321: f= 326.712, eps=0.005163456
Epoch 322: f= 326.699, eps=0.005421629
Epoch 323: f= 326.685, eps=0.005692711
Epoch 324: f= 326.671, eps=0.005977346
Epoch 325: f= 326.656, eps=0.006276214
Epoch 326: f= 326.641, eps=0.006590024
Epoch 327: f= 326.625, eps=0.006919525
Epoch 328: f= 326.608, eps=0.007265502
Epoch 329: f= 326.590, eps=0.007628777
Epoch 330: f= 326.572, eps=0.008010216
Epoch 331: f= 326.553, eps=0.008410726
Epoch 332: f= 326.533, eps=0.008831263
Epoch 333: f= 326.518, eps=0.009272826
Epoch 334: f= 326.502, eps=0.009728902
Epoch 335: f= 326.485, eps=0.010200000
Epoch 336: f= 326.467, eps=0.010686250
Epoch 337: f= 326.449, eps=0.011186750
Epoch 338: f= 326.431, eps=0.011700500
Epoch 339: f= 326.413, eps=0.012227500
Epoch 340: f= 326.395, eps=0.012767750
Epoch 341: f= 326.377, eps=0.013321250
Epoch 342: f= 326.359, eps=0.013888000
Epoch 343: f= 326.341, eps=0.014468000
Epoch 344: f= 326.323, eps=0.015061250
Epoch 345: f= 326.305, eps=0.015667750
Epoch 346: f= 326.287, eps=0.016287500
Epoch 347: f= 326.269, eps=0.016920500
Epoch 348: f= 326.251, eps=0.017566750
Epoch 349: f= 326.233, eps=0.018226250
Epoch 350: f= 326.215, eps=0.018900000
Epoch 351: f= 326.197, eps=0.019588000
Epoch 352: f= 326.179, eps=0.020290250
Epoch 353: f= 326.161, eps=0.021006000
Epoch 354: f= 326.143, eps=0.021735250
Epoch 355: f= 326.125, eps=0.022479000
Epoch 356: f= 326.107, eps=0.023237250
Epoch 357: f= 326.089, eps=0.024010000
Epoch 358: f= 326.071, eps=0.024797250
Epoch 359: f= 326.053, eps=0.025599000
Epoch 360: f= 326.035, eps=0.026415250
Epoch 361: f= 326.017, eps=0.027246000
Epoch 362: f= 325.999, eps=0.028091250

Epoch 363: f= 326.182, eps=0.009087669
Epoch 364: f= 326.163, eps=0.009542052
Epoch 365: f= 326.144, eps=0.010019155
Epoch 366: f= 326.123, eps=0.010520113
Epoch 367: f= 326.105, eps=0.011046118
Epoch 368: f= 326.126, eps=0.005523059
Epoch 369: f= 326.159, eps=0.002761530
Epoch 370: f= 326.073, eps=0.002899606
Epoch 371: f= 326.058, eps=0.003044586
Epoch 372: f= 326.051, eps=0.003196816
Epoch 373: f= 326.045, eps=0.003356656
Epoch 374: f= 326.038, eps=0.003524489
Epoch 375: f= 326.032, eps=0.003700714
Epoch 376: f= 326.024, eps=0.003885749
Epoch 377: f= 326.017, eps=0.004080037
Epoch 378: f= 326.009, eps=0.004284039
Epoch 379: f= 326.001, eps=0.004498241
Epoch 380: f= 325.992, eps=0.004723153
Epoch 381: f= 325.983, eps=0.004959310
Epoch 382: f= 325.973, eps=0.005207276
Epoch 383: f= 325.963, eps=0.005467640
Epoch 384: f= 325.953, eps=0.005741022
Epoch 385: f= 325.942, eps=0.006028073
Epoch 386: f= 325.931, eps=0.006329476
Epoch 387: f= 325.919, eps=0.006645950
Epoch 388: f= 325.907, eps=0.006978248
Epoch 389: f= 325.894, eps=0.007327160
Epoch 390: f= 325.886, eps=0.007693518
Epoch 391: f= 325.900, eps=0.003846759
Epoch 392: f= 325.881, eps=0.004039097
Epoch 393: f= 325.864, eps=0.004241052
Epoch 394: f= 325.855, eps=0.004453104
Epoch 395: f= 325.846, eps=0.004675760
Epoch 396: f= 325.841, eps=0.004909548
Epoch 397: f= 325.838, eps=0.005155025
Epoch 398: f= 325.845, eps=0.002577512
Epoch 399: f= 325.805, eps=0.002706388
Epoch 400: f= 325.800, eps=0.002841708
Epoch 401: f= 325.795, eps=0.002983793
Epoch 402: f= 325.789, eps=0.003132983
Epoch 403: f= 325.784, eps=0.003289632
Epoch 404: f= 325.778, eps=0.003454113
Epoch 405: f= 325.772, eps=0.003626819
Epoch 406: f= 325.766, eps=0.003808160
Epoch 407: f= 325.759, eps=0.003998568
Epoch 408: f= 325.752, eps=0.004198496
Epoch 409: f= 325.745, eps=0.004408421
Epoch 410: f= 325.737, eps=0.004628842

Epoch 411: f= 325.729, eps=0.004860284
Epoch 412: f= 325.721, eps=0.005103298
Epoch 413: f= 325.712, eps=0.005358463
Epoch 414: f= 325.703, eps=0.005626387
Epoch 415: f= 325.693, eps=0.005907706
Epoch 416: f= 325.683, eps=0.006203091
Epoch 417: f= 325.673, eps=0.006513246
Epoch 418: f= 325.662, eps=0.006838908
Epoch 419: f= 325.650, eps=0.007180853
Epoch 420: f= 325.639, eps=0.007539896
Epoch 421: f= 325.626, eps=0.007916891
Epoch 422: f= 325.613, eps=0.008312735
Epoch 423: f= 325.600, eps=0.008728372
Epoch 424: f= 325.592, eps=0.009164791
Epoch 425: f= 325.638, eps=0.004582395
Epoch 426: f= 325.653, eps=0.002291198
Epoch 427: f= 325.560, eps=0.002405758
Epoch 428: f= 325.556, eps=0.002526045
Epoch 429: f= 325.552, eps=0.002652348
Epoch 430: f= 325.548, eps=0.002784965
Epoch 431: f= 325.543, eps=0.002924213
Epoch 432: f= 325.539, eps=0.003070424
Epoch 433: f= 325.534, eps=0.003223945
Epoch 434: f= 325.529, eps=0.003385142
Epoch 435: f= 325.523, eps=0.003554400
Epoch 436: f= 325.518, eps=0.003732120
Epoch 437: f= 325.512, eps=0.003918726
Epoch 438: f= 325.506, eps=0.004114662
Epoch 439: f= 325.500, eps=0.004320395
Epoch 440: f= 325.493, eps=0.004536415
Epoch 441: f= 325.486, eps=0.004763235
Epoch 442: f= 325.479, eps=0.005001397
Epoch 443: f= 325.471, eps=0.005251467
Epoch 444: f= 325.463, eps=0.005514040
Epoch 445: f= 325.455, eps=0.005789742
Epoch 446: f= 325.446, eps=0.006079230
Epoch 447: f= 325.437, eps=0.006383191
Epoch 448: f= 325.427, eps=0.006702351
Epoch 449: f= 325.417, eps=0.007037468
Epoch 450: f= 325.407, eps=0.007389342
Epoch 451: f= 325.396, eps=0.007758809
Epoch 452: f= 325.385, eps=0.008146749
Epoch 453: f= 325.373, eps=0.008554086
Epoch 454: f= 325.360, eps=0.008981791
Epoch 455: f= 325.347, eps=0.009430880
Epoch 456: f= 325.334, eps=0.009902424
Epoch 457: f= 325.320, eps=0.010397546
Epoch 458: f= 325.307, eps=0.010917423

Epoch 459: f= 325.324, eps=0.005458711
 Epoch 460: f= 325.348, eps=0.002729356
 Epoch 461: f= 325.285, eps=0.002865824
 Epoch 462: f= 325.275, eps=0.003009115
 Epoch 463: f= 325.271, eps=0.003159570
 Epoch 464: f= 325.266, eps=0.003317549
 Epoch 465: f= 325.262, eps=0.003483426
 Epoch 466: f= 325.257, eps=0.003657598
 Epoch 467: f= 325.252, eps=0.003840478
 Epoch 468: f= 325.247, eps=0.004032501
 Epoch 469: f= 325.241, eps=0.004234127
 Epoch 470: f= 325.236, eps=0.004445833
 Epoch 471: f= 325.230, eps=0.004668125
 Epoch 472: f= 325.223, eps=0.004901531
 Epoch 473: f= 325.217, eps=0.005146607
 Epoch 474: f= 325.210, eps=0.005403938
 Epoch 475: f= 325.203, eps=0.005674135
 Epoch 476: f= 325.195, eps=0.005957841
 Epoch 477: f= 325.187, eps=0.006255733
 Epoch 478: f= 325.179, eps=0.006568520
 Epoch 479: f= 325.171, eps=0.006896946
 Epoch 480: f= 325.162, eps=0.007241793
 Epoch 481: f= 325.155, eps=0.007603883
 Epoch 482: f= 325.159, eps=0.003801941
 Epoch 483: f= 325.148, eps=0.003992039
 Epoch 484: f= 325.139, eps=0.004191640
 Epoch 485: f= 325.133, eps=0.004401222
 Epoch 486: f= 325.127, eps=0.004621284
 Epoch 487: f= 325.122, eps=0.004852348
 Epoch 488: f= 325.118, eps=0.005094965
 Epoch 489: f= 325.119, eps=0.002547483
 Epoch 490: f= 325.101, eps=0.002674857
 Epoch 491: f= 325.097, eps=0.002808600
 Epoch 492: f= 325.094, eps=0.002949030
 Epoch 493: f= 325.090, eps=0.003096481
 Epoch 494: f= 325.086, eps=0.003251305
 Epoch 495: f= 325.082, eps=0.003413870
 Epoch 496: f= 325.078, eps=0.003584564
 Epoch 497: f= 325.073, eps=0.003763792
 Epoch 498: f= 325.069, eps=0.003951982
 Epoch 499: f= 325.064, eps=0.004149581
 Result after 500 epochs: f=325.0589707546104
 Epoch 0: f= 3420.297, eps=0.010000000
 Epoch 1: f= 1357.315, eps=0.010500000
 Epoch 2: f= 830.666, eps=0.011025000
 Epoch 3: f= 605.028, eps=0.011576250
 Epoch 4: f= 555.800, eps=0.012155063
 Epoch 5: f= 492.418, eps=0.012762816

Epoch	6: f=	523.818, eps=0.006381408
Epoch	7: f=	438.739, eps=0.006700478
Epoch	8: f=	407.741, eps=0.007035502
Epoch	9: f=	401.463, eps=0.007387277
Epoch	10: f=	397.962, eps=0.007756641
Epoch	11: f=	405.507, eps=0.003878321
Epoch	12: f=	386.305, eps=0.004072237
Epoch	13: f=	383.879, eps=0.004275848
Epoch	14: f=	382.163, eps=0.004489641
Epoch	15: f=	380.567, eps=0.004714123
Epoch	16: f=	379.223, eps=0.004949829
Epoch	17: f=	377.763, eps=0.005197320
Epoch	18: f=	376.830, eps=0.005457186
Epoch	19: f=	375.254, eps=0.005730046
Epoch	20: f=	375.094, eps=0.006016548
Epoch	21: f=	373.183, eps=0.006317375
Epoch	22: f=	374.766, eps=0.003158688
Epoch	23: f=	366.097, eps=0.003316622
Epoch	24: f=	365.264, eps=0.003482453
Epoch	25: f=	364.448, eps=0.003656576
Epoch	26: f=	363.644, eps=0.003839405
Epoch	27: f=	362.826, eps=0.004031375
Epoch	28: f=	362.031, eps=0.004232944
Epoch	29: f=	361.236, eps=0.004444591
Epoch	30: f=	360.570, eps=0.004666820
Epoch	31: f=	359.908, eps=0.004900161
Epoch	32: f=	359.753, eps=0.005145169
Epoch	33: f=	358.988, eps=0.005402428
Epoch	34: f=	359.503, eps=0.002701214
Epoch	35: f=	356.160, eps=0.002836275
Epoch	36: f=	355.627, eps=0.002978088
Epoch	37: f=	355.147, eps=0.003126993
Epoch	38: f=	354.662, eps=0.003283342
Epoch	39: f=	354.168, eps=0.003447510
Epoch	40: f=	353.662, eps=0.003619885
Epoch	41: f=	353.147, eps=0.003800879
Epoch	42: f=	352.621, eps=0.003990923
Epoch	43: f=	352.087, eps=0.004190469
Epoch	44: f=	351.546, eps=0.004399993
Epoch	45: f=	350.998, eps=0.004619993
Epoch	46: f=	350.447, eps=0.004850992
Epoch	47: f=	349.896, eps=0.005093542
Epoch	48: f=	349.355, eps=0.005348219
Epoch	49: f=	348.857, eps=0.005615630
Epoch	50: f=	348.477, eps=0.005896411
Epoch	51: f=	348.626, eps=0.002948206
Epoch	52: f=	347.415, eps=0.003095616
Epoch	53: f=	347.151, eps=0.003250397

Epoch 54: f= 346.888, eps=0.003412917
 Epoch 55: f= 346.624, eps=0.003583562
 Epoch 56: f= 346.359, eps=0.003762741
 Epoch 57: f= 346.096, eps=0.003950878
 Epoch 58: f= 345.836, eps=0.004148421
 Epoch 59: f= 345.579, eps=0.004355843
 Epoch 60: f= 345.329, eps=0.004573635
 Epoch 61: f= 345.085, eps=0.004802316
 Epoch 62: f= 344.850, eps=0.005042432
 Epoch 63: f= 344.624, eps=0.005294554
 Epoch 64: f= 344.407, eps=0.005559282
 Epoch 65: f= 344.200, eps=0.005837246
 Epoch 66: f= 344.006, eps=0.006129108
 Epoch 67: f= 343.843, eps=0.006435563
 Epoch 68: f= 343.780, eps=0.006757341
 Epoch 69: f= 344.223, eps=0.003378671
 Epoch 70: f= 343.365, eps=0.003547604
 Epoch 71: f= 343.264, eps=0.003724984
 Epoch 72: f= 343.172, eps=0.003911234
 Epoch 73: f= 343.081, eps=0.004106795
 Epoch 74: f= 342.990, eps=0.004312135
 Epoch 75: f= 342.899, eps=0.004527742
 Epoch 76: f= 342.807, eps=0.004754129
 Epoch 77: f= 342.716, eps=0.004991835
 Epoch 78: f= 342.627, eps=0.005241427
 Epoch 79: f= 342.546, eps=0.005503499
 Epoch 80: f= 342.482, eps=0.005778674
 Epoch 81: f= 342.505, eps=0.002889337
 Epoch 82: f= 342.284, eps=0.003033804
 Epoch 83: f= 342.232, eps=0.003185494
 Epoch 84: f= 342.182, eps=0.003344768
 Epoch 85: f= 342.131, eps=0.003512007
 Epoch 86: f= 342.079, eps=0.003687607
 Epoch 87: f= 342.026, eps=0.003871988
 Epoch 88: f= 341.971, eps=0.004065587
 Epoch 89: f= 341.915, eps=0.004268866
 Epoch 90: f= 341.858, eps=0.004482310
 Epoch 91: f= 341.800, eps=0.004706425
 Epoch 92: f= 341.740, eps=0.004941746
 Epoch 93: f= 341.679, eps=0.005188834
 Epoch 94: f= 341.618, eps=0.005448275
 Epoch 95: f= 341.555, eps=0.005720689
 Epoch 96: f= 341.491, eps=0.006006724
 Epoch 97: f= 341.426, eps=0.006307060
 Epoch 98: f= 341.362, eps=0.006622413
 Epoch 99: f= 341.299, eps=0.006953533
 Epoch 100: f= 341.252, eps=0.007301210
 Epoch 101: f= 341.295, eps=0.003650605

Epoch 102: f= 341.157, eps=0.003833135
Epoch 103: f= 341.109, eps=0.004024792
Epoch 104: f= 341.066, eps=0.004226032
Epoch 105: f= 341.029, eps=0.004437333
Epoch 106: f= 340.991, eps=0.004659200
Epoch 107: f= 340.955, eps=0.004892160
Epoch 108: f= 340.920, eps=0.005136768
Epoch 109: f= 340.890, eps=0.005393606
Epoch 110: f= 340.870, eps=0.005663287
Epoch 111: f= 340.893, eps=0.002831643
Epoch 112: f= 340.766, eps=0.002973225
Epoch 113: f= 340.741, eps=0.003121887
Epoch 114: f= 340.719, eps=0.003277981
Epoch 115: f= 340.696, eps=0.003441880
Epoch 116: f= 340.672, eps=0.003613974
Epoch 117: f= 340.648, eps=0.003794673
Epoch 118: f= 340.622, eps=0.003984406
Epoch 119: f= 340.596, eps=0.004183627
Epoch 120: f= 340.569, eps=0.004392808
Epoch 121: f= 340.541, eps=0.004612449
Epoch 122: f= 340.513, eps=0.004843071
Epoch 123: f= 340.483, eps=0.005085225
Epoch 124: f= 340.453, eps=0.005339486
Epoch 125: f= 340.421, eps=0.005606460
Epoch 126: f= 340.389, eps=0.005886783
Epoch 127: f= 340.356, eps=0.006181122
Epoch 128: f= 340.322, eps=0.006490178
Epoch 129: f= 340.287, eps=0.006814687
Epoch 130: f= 340.252, eps=0.007155422
Epoch 131: f= 340.216, eps=0.007513193
Epoch 132: f= 340.183, eps=0.007888852
Epoch 133: f= 340.175, eps=0.008283295
Epoch 134: f= 340.351, eps=0.004141647
Epoch 135: f= 340.241, eps=0.004348730
Epoch 136: f= 340.170, eps=0.004566166
Epoch 137: f= 340.146, eps=0.004794475
Epoch 138: f= 340.141, eps=0.005034198
Epoch 139: f= 340.165, eps=0.002517099
Epoch 140: f= 339.990, eps=0.002642954
Epoch 141: f= 339.975, eps=0.002775102
Epoch 142: f= 339.963, eps=0.002913857
Epoch 143: f= 339.951, eps=0.003059550
Epoch 144: f= 339.938, eps=0.003212527
Epoch 145: f= 339.925, eps=0.003373154
Epoch 146: f= 339.911, eps=0.003541811
Epoch 147: f= 339.897, eps=0.003718902
Epoch 148: f= 339.882, eps=0.003904847
Epoch 149: f= 339.867, eps=0.004100089

Epoch 150: f= 339.851, eps=0.004305094
Epoch 151: f= 339.834, eps=0.004520348
Epoch 152: f= 339.817, eps=0.004746366
Epoch 153: f= 339.800, eps=0.004983684
Epoch 154: f= 339.781, eps=0.005232868
Epoch 155: f= 339.762, eps=0.005494512
Epoch 156: f= 339.742, eps=0.005769237
Epoch 157: f= 339.722, eps=0.006057699
Epoch 158: f= 339.701, eps=0.006360584
Epoch 159: f= 339.679, eps=0.006678613
Epoch 160: f= 339.657, eps=0.007012544
Epoch 161: f= 339.634, eps=0.007363171
Epoch 162: f= 339.610, eps=0.007731330
Epoch 163: f= 339.586, eps=0.008117896
Epoch 164: f= 339.561, eps=0.008523791
Epoch 165: f= 339.535, eps=0.008949981
Epoch 166: f= 339.509, eps=0.009397480
Epoch 167: f= 339.489, eps=0.009867354
Epoch 168: f= 339.540, eps=0.004933677
Epoch 169: f= 339.541, eps=0.002466838
Epoch 170: f= 339.435, eps=0.002590180
Epoch 171: f= 339.426, eps=0.002719689
Epoch 172: f= 339.419, eps=0.002855674
Epoch 173: f= 339.411, eps=0.002998458
Epoch 174: f= 339.403, eps=0.003148380
Epoch 175: f= 339.395, eps=0.003305799
Epoch 176: f= 339.386, eps=0.003471089
Epoch 177: f= 339.377, eps=0.003644644
Epoch 178: f= 339.368, eps=0.003826876
Epoch 179: f= 339.358, eps=0.004018220
Epoch 180: f= 339.348, eps=0.004219131
Epoch 181: f= 339.337, eps=0.004430087
Epoch 182: f= 339.326, eps=0.004651592
Epoch 183: f= 339.315, eps=0.004884171
Epoch 184: f= 339.303, eps=0.005128380
Epoch 185: f= 339.291, eps=0.005384799
Epoch 186: f= 339.278, eps=0.005654039
Epoch 187: f= 339.265, eps=0.005936741
Epoch 188: f= 339.251, eps=0.006233578
Epoch 189: f= 339.237, eps=0.006545257
Epoch 190: f= 339.222, eps=0.006872520
Epoch 191: f= 339.207, eps=0.007216146
Epoch 192: f= 339.191, eps=0.007576953
Epoch 193: f= 339.175, eps=0.007955801
Epoch 194: f= 339.158, eps=0.008353591
Epoch 195: f= 339.141, eps=0.008771270
Epoch 196: f= 339.123, eps=0.009209834
Epoch 197: f= 339.105, eps=0.009670325

Epoch 198: f= 339.092, eps=0.010153842
Epoch 199: f= 339.138, eps=0.005076921
Epoch 200: f= 339.180, eps=0.002538460
Epoch 201: f= 339.052, eps=0.002665383
Epoch 202: f= 339.047, eps=0.002798653
Epoch 203: f= 339.042, eps=0.002938585
Epoch 204: f= 339.037, eps=0.003085514
Epoch 205: f= 339.031, eps=0.003239790
Epoch 206: f= 339.025, eps=0.003401780
Epoch 207: f= 339.019, eps=0.003571869
Epoch 208: f= 339.013, eps=0.003750462
Epoch 209: f= 339.006, eps=0.003937985
Epoch 210: f= 338.999, eps=0.004134885
Epoch 211: f= 338.992, eps=0.004341629
Epoch 212: f= 338.985, eps=0.004558710
Epoch 213: f= 338.977, eps=0.004786646
Epoch 214: f= 338.969, eps=0.005025978
Epoch 215: f= 338.961, eps=0.005277277
Epoch 216: f= 338.952, eps=0.005541141
Epoch 217: f= 338.943, eps=0.005818198
Epoch 218: f= 338.933, eps=0.006109108
Epoch 219: f= 338.924, eps=0.006414563
Epoch 220: f= 338.914, eps=0.006735291
Epoch 221: f= 338.903, eps=0.007072056
Epoch 222: f= 338.892, eps=0.007425659
Epoch 223: f= 338.881, eps=0.007796941
Epoch 224: f= 338.869, eps=0.008186788
Epoch 225: f= 338.857, eps=0.008596128
Epoch 226: f= 338.845, eps=0.009025934
Epoch 227: f= 338.832, eps=0.009477231
Epoch 228: f= 338.819, eps=0.009951093
Epoch 229: f= 338.809, eps=0.010448647
Epoch 230: f= 338.837, eps=0.005224324
Epoch 231: f= 338.853, eps=0.002612162
Epoch 232: f= 338.785, eps=0.002742770
Epoch 233: f= 338.778, eps=0.002879908
Epoch 234: f= 338.774, eps=0.003023904
Epoch 235: f= 338.770, eps=0.003175099
Epoch 236: f= 338.766, eps=0.003333854
Epoch 237: f= 338.762, eps=0.003500547
Epoch 238: f= 338.758, eps=0.003675574
Epoch 239: f= 338.753, eps=0.003859353
Epoch 240: f= 338.748, eps=0.004052320
Epoch 241: f= 338.743, eps=0.004254936
Epoch 242: f= 338.738, eps=0.004467683
Epoch 243: f= 338.733, eps=0.004691067
Epoch 244: f= 338.727, eps=0.004925621
Epoch 245: f= 338.721, eps=0.005171902

Epoch 246: f= 338.715, eps=0.005430497
Epoch 247: f= 338.709, eps=0.005702022
Epoch 248: f= 338.702, eps=0.005987123
Epoch 249: f= 338.695, eps=0.006286479
Epoch 250: f= 338.688, eps=0.006600803
Epoch 251: f= 338.681, eps=0.006930843
Epoch 252: f= 338.673, eps=0.007277385
Epoch 253: f= 338.665, eps=0.007641254
Epoch 254: f= 338.657, eps=0.008023317
Epoch 255: f= 338.649, eps=0.008424483
Epoch 256: f= 338.642, eps=0.008845707
Epoch 257: f= 338.650, eps=0.004422854
Epoch 258: f= 338.646, eps=0.004643996
Epoch 259: f= 338.641, eps=0.004876196
Epoch 260: f= 338.645, eps=0.002438098
Epoch 261: f= 338.615, eps=0.002560003
Epoch 262: f= 338.612, eps=0.002688003
Epoch 263: f= 338.610, eps=0.002822403
Epoch 264: f= 338.607, eps=0.002963523
Epoch 265: f= 338.604, eps=0.003111700
Epoch 266: f= 338.601, eps=0.003267285
Epoch 267: f= 338.598, eps=0.003430649
Epoch 268: f= 338.595, eps=0.003602181
Epoch 269: f= 338.591, eps=0.003782290
Epoch 270: f= 338.588, eps=0.003971405
Epoch 271: f= 338.584, eps=0.004169975
Epoch 272: f= 338.580, eps=0.004378474
Epoch 273: f= 338.576, eps=0.004597397
Epoch 274: f= 338.572, eps=0.004827267
Epoch 275: f= 338.568, eps=0.005068631
Epoch 276: f= 338.563, eps=0.005322062
Epoch 277: f= 338.559, eps=0.005588165
Epoch 278: f= 338.554, eps=0.005867574
Epoch 279: f= 338.549, eps=0.006160952
Epoch 280: f= 338.544, eps=0.006469000
Epoch 281: f= 338.538, eps=0.006792450
Epoch 282: f= 338.532, eps=0.007132072
Epoch 283: f= 338.527, eps=0.007488676
Epoch 284: f= 338.521, eps=0.007863110
Epoch 285: f= 338.514, eps=0.008256265
Epoch 286: f= 338.508, eps=0.008669078
Epoch 287: f= 338.501, eps=0.009102532
Epoch 288: f= 338.494, eps=0.009557659
Epoch 289: f= 338.487, eps=0.010035542
Epoch 290: f= 338.480, eps=0.010537319
Epoch 291: f= 338.476, eps=0.011064185
Epoch 292: f= 338.530, eps=0.005532093
Epoch 293: f= 338.578, eps=0.002766046

Epoch 294: f= 338.470, eps=0.002904349
Epoch 295: f= 338.457, eps=0.003049566
Epoch 296: f= 338.454, eps=0.003202044
Epoch 297: f= 338.452, eps=0.003362147
Epoch 298: f= 338.450, eps=0.003530254
Epoch 299: f= 338.447, eps=0.003706767
Epoch 300: f= 338.445, eps=0.003892105
Epoch 301: f= 338.442, eps=0.004086710
Epoch 302: f= 338.440, eps=0.004291046
Epoch 303: f= 338.437, eps=0.004505598
Epoch 304: f= 338.434, eps=0.004730878
Epoch 305: f= 338.431, eps=0.004967422
Epoch 306: f= 338.428, eps=0.005215793
Epoch 307: f= 338.424, eps=0.005476582
Epoch 308: f= 338.421, eps=0.005750412
Epoch 309: f= 338.417, eps=0.006037932
Epoch 310: f= 338.414, eps=0.006339829
Epoch 311: f= 338.410, eps=0.006656820
Epoch 312: f= 338.406, eps=0.006989661
Epoch 313: f= 338.402, eps=0.007339144
Epoch 314: f= 338.399, eps=0.007706101
Epoch 315: f= 338.402, eps=0.003853051
Epoch 316: f= 338.396, eps=0.004045703
Epoch 317: f= 338.391, eps=0.004247988
Epoch 318: f= 338.388, eps=0.004460388
Epoch 319: f= 338.386, eps=0.004683407
Epoch 320: f= 338.384, eps=0.004917578
Epoch 321: f= 338.382, eps=0.005163456
Epoch 322: f= 338.382, eps=0.005421629
Epoch 323: f= 338.384, eps=0.002710815
Epoch 324: f= 338.372, eps=0.002846355
Epoch 325: f= 338.370, eps=0.002988673
Epoch 326: f= 338.368, eps=0.003138107
Epoch 327: f= 338.366, eps=0.003295012
Epoch 328: f= 338.365, eps=0.003459763
Epoch 329: f= 338.363, eps=0.003632751
Epoch 330: f= 338.361, eps=0.003814388
Epoch 331: f= 338.359, eps=0.004005108
Epoch 332: f= 338.357, eps=0.004205363
Epoch 333: f= 338.355, eps=0.004415631
Epoch 334: f= 338.352, eps=0.004636413
Epoch 335: f= 338.350, eps=0.004868234
Epoch 336: f= 338.348, eps=0.005111645
Epoch 337: f= 338.345, eps=0.005367228
Epoch 338: f= 338.343, eps=0.005635589
Epoch 339: f= 338.340, eps=0.005917368
Epoch 340: f= 338.337, eps=0.006213237
Epoch 341: f= 338.334, eps=0.006523899

Epoch 342: f= 338.331, eps=0.006850094
Epoch 343: f= 338.328, eps=0.007192598
Epoch 344: f= 338.325, eps=0.007552228
Epoch 345: f= 338.321, eps=0.007929840
Epoch 346: f= 338.318, eps=0.008326332
Epoch 347: f= 338.319, eps=0.004163166
Epoch 348: f= 338.316, eps=0.004371324
Epoch 349: f= 338.314, eps=0.004589890
Epoch 350: f= 338.312, eps=0.004819385
Epoch 351: f= 338.311, eps=0.005060354
Epoch 352: f= 338.311, eps=0.002530177
Epoch 353: f= 338.303, eps=0.002656686
Epoch 354: f= 338.302, eps=0.002789520
Epoch 355: f= 338.301, eps=0.002928996
Epoch 356: f= 338.300, eps=0.003075446
Epoch 357: f= 338.299, eps=0.003229218
Epoch 358: f= 338.297, eps=0.003390679
Epoch 359: f= 338.296, eps=0.003560213
Epoch 360: f= 338.294, eps=0.003738224
Epoch 361: f= 338.293, eps=0.003925135
Epoch 362: f= 338.291, eps=0.004121392
Epoch 363: f= 338.290, eps=0.004327461
Epoch 364: f= 338.288, eps=0.004543834
Epoch 365: f= 338.286, eps=0.004771026
Epoch 366: f= 338.285, eps=0.005009577
Epoch 367: f= 338.283, eps=0.005260056
Epoch 368: f= 338.281, eps=0.005523059
Epoch 369: f= 338.279, eps=0.005799212
Epoch 370: f= 338.276, eps=0.006089173
Epoch 371: f= 338.274, eps=0.006393631
Epoch 372: f= 338.272, eps=0.006713313
Epoch 373: f= 338.270, eps=0.007048978
Epoch 374: f= 338.267, eps=0.007401427
Epoch 375: f= 338.264, eps=0.007771499
Epoch 376: f= 338.262, eps=0.008160074
Epoch 377: f= 338.259, eps=0.008568077
Epoch 378: f= 338.256, eps=0.008996481
Epoch 379: f= 338.253, eps=0.009446305
Epoch 380: f= 338.252, eps=0.009918621
Epoch 381: f= 338.267, eps=0.004959310
Epoch 382: f= 338.276, eps=0.002479655
Epoch 383: f= 338.245, eps=0.002603638
Epoch 384: f= 338.244, eps=0.002733820
Epoch 385: f= 338.243, eps=0.002870511
Epoch 386: f= 338.242, eps=0.003014036
Epoch 387: f= 338.241, eps=0.003164738
Epoch 388: f= 338.240, eps=0.003322975
Epoch 389: f= 338.239, eps=0.003489124

Epoch 390: f= 338.238, eps=0.003663580
Epoch 391: f= 338.237, eps=0.003846759
Epoch 392: f= 338.236, eps=0.004039097
Epoch 393: f= 338.235, eps=0.004241052
Epoch 394: f= 338.233, eps=0.004453104
Epoch 395: f= 338.232, eps=0.004675760
Epoch 396: f= 338.231, eps=0.004909548
Epoch 397: f= 338.229, eps=0.005155025
Epoch 398: f= 338.228, eps=0.005412776
Epoch 399: f= 338.226, eps=0.005683415
Epoch 400: f= 338.225, eps=0.005967586
Epoch 401: f= 338.223, eps=0.006265965
Epoch 402: f= 338.221, eps=0.006579263
Epoch 403: f= 338.220, eps=0.006908226
Epoch 404: f= 338.218, eps=0.007253638
Epoch 405: f= 338.216, eps=0.007616320
Epoch 406: f= 338.214, eps=0.007997136
Epoch 407: f= 338.212, eps=0.008396992
Epoch 408: f= 338.210, eps=0.008816842
Epoch 409: f= 338.207, eps=0.009257684
Epoch 410: f= 338.205, eps=0.009720568
Epoch 411: f= 338.204, eps=0.010206597
Epoch 412: f= 338.219, eps=0.005103298
Epoch 413: f= 338.227, eps=0.002551649
Epoch 414: f= 338.199, eps=0.002679232
Epoch 415: f= 338.198, eps=0.002813193
Epoch 416: f= 338.197, eps=0.002953853
Epoch 417: f= 338.197, eps=0.003101546
Epoch 418: f= 338.196, eps=0.003256623
Epoch 419: f= 338.195, eps=0.003419454
Epoch 420: f= 338.194, eps=0.003590427
Epoch 421: f= 338.193, eps=0.003769948
Epoch 422: f= 338.193, eps=0.003958445
Epoch 423: f= 338.192, eps=0.004156368
Epoch 424: f= 338.191, eps=0.004364186
Epoch 425: f= 338.190, eps=0.004582395
Epoch 426: f= 338.189, eps=0.004811515
Epoch 427: f= 338.188, eps=0.005052091
Epoch 428: f= 338.187, eps=0.005304695
Epoch 429: f= 338.186, eps=0.005569930
Epoch 430: f= 338.184, eps=0.005848427
Epoch 431: f= 338.183, eps=0.006140848
Epoch 432: f= 338.182, eps=0.006447890
Epoch 433: f= 338.181, eps=0.006770285
Epoch 434: f= 338.179, eps=0.007108799
Epoch 435: f= 338.178, eps=0.007464239
Epoch 436: f= 338.176, eps=0.007837451
Epoch 437: f= 338.175, eps=0.008229324

Epoch 438: f= 338.173, eps=0.008640790
Epoch 439: f= 338.172, eps=0.009072829
Epoch 440: f= 338.177, eps=0.004536415
Epoch 441: f= 338.176, eps=0.004763235
Epoch 442: f= 338.177, eps=0.002381618
Epoch 443: f= 338.168, eps=0.002500699
Epoch 444: f= 338.167, eps=0.002625734
Epoch 445: f= 338.167, eps=0.002757020
Epoch 446: f= 338.166, eps=0.002894871
Epoch 447: f= 338.166, eps=0.003039615
Epoch 448: f= 338.165, eps=0.003191596
Epoch 449: f= 338.165, eps=0.003351175
Epoch 450: f= 338.164, eps=0.003518734
Epoch 451: f= 338.164, eps=0.003694671
Epoch 452: f= 338.163, eps=0.003879404
Epoch 453: f= 338.162, eps=0.004073375
Epoch 454: f= 338.162, eps=0.004277043
Epoch 455: f= 338.161, eps=0.004490895
Epoch 456: f= 338.160, eps=0.004715440
Epoch 457: f= 338.159, eps=0.004951212
Epoch 458: f= 338.159, eps=0.005198773
Epoch 459: f= 338.158, eps=0.005458711
Epoch 460: f= 338.157, eps=0.005731647
Epoch 461: f= 338.156, eps=0.006018229
Epoch 462: f= 338.155, eps=0.006319141
Epoch 463: f= 338.154, eps=0.006635098
Epoch 464: f= 338.153, eps=0.006966853
Epoch 465: f= 338.152, eps=0.007315195
Epoch 466: f= 338.151, eps=0.007680955
Epoch 467: f= 338.149, eps=0.008065003
Epoch 468: f= 338.148, eps=0.008468253
Epoch 469: f= 338.147, eps=0.008891666
Epoch 470: f= 338.146, eps=0.009336249
Epoch 471: f= 338.144, eps=0.009803061
Epoch 472: f= 338.143, eps=0.010293215
Epoch 473: f= 338.142, eps=0.010807875
Epoch 474: f= 338.142, eps=0.005403938
Epoch 475: f= 338.143, eps=0.002701969
Epoch 476: f= 338.139, eps=0.002837067
Epoch 477: f= 338.139, eps=0.002978921
Epoch 478: f= 338.138, eps=0.003127867
Epoch 479: f= 338.138, eps=0.003284260
Epoch 480: f= 338.137, eps=0.003448473
Epoch 481: f= 338.137, eps=0.003620897
Epoch 482: f= 338.137, eps=0.003801941
Epoch 483: f= 338.136, eps=0.003992039
Epoch 484: f= 338.136, eps=0.004191640
Epoch 485: f= 338.135, eps=0.004401222

Epoch 486: f= 338.134, eps=0.004621284
 Epoch 487: f= 338.134, eps=0.004852348
 Epoch 488: f= 338.133, eps=0.005094965
 Epoch 489: f= 338.133, eps=0.005349713
 Epoch 490: f= 338.132, eps=0.005617199
 Epoch 491: f= 338.131, eps=0.005898059
 Epoch 492: f= 338.131, eps=0.006192962
 Epoch 493: f= 338.130, eps=0.006502610
 Epoch 494: f= 338.129, eps=0.006827741
 Epoch 495: f= 338.128, eps=0.007169128
 Epoch 496: f= 338.128, eps=0.007527584
 Epoch 497: f= 338.127, eps=0.007903963
 Epoch 498: f= 338.126, eps=0.008299161
 Epoch 499: f= 338.126, eps=0.004149581
 Result after 500 epochs: f=338.1256197756515
 Epoch 0: f= 3437.078, eps=0.010000000
 Epoch 1: f= 1383.004, eps=0.010500000
 Epoch 2: f= 845.939, eps=0.011025000
 Epoch 3: f= 617.843, eps=0.011576250
 Epoch 4: f= 568.291, eps=0.012155063
 Epoch 5: f= 505.428, eps=0.012762816
 Epoch 6: f= 538.784, eps=0.006381408
 Epoch 7: f= 447.927, eps=0.006700478
 Epoch 8: f= 415.280, eps=0.007035502
 Epoch 9: f= 408.716, eps=0.007387277
 Epoch 10: f= 402.908, eps=0.007756641
 Epoch 11: f= 404.614, eps=0.003878321
 Epoch 12: f= 393.981, eps=0.004072237
 Epoch 13: f= 390.998, eps=0.004275848
 Epoch 14: f= 389.170, eps=0.004489641
 Epoch 15: f= 387.329, eps=0.004714123
 Epoch 16: f= 385.975, eps=0.004949829
 Epoch 17: f= 384.267, eps=0.005197320
 Epoch 18: f= 383.436, eps=0.005457186
 Epoch 19: f= 381.534, eps=0.005730046
 Epoch 20: f= 381.627, eps=0.002865023
 Epoch 21: f= 375.424, eps=0.003008274
 Epoch 22: f= 374.547, eps=0.003158688
 Epoch 23: f= 373.670, eps=0.003316622
 Epoch 24: f= 372.788, eps=0.003482453
 Epoch 25: f= 371.894, eps=0.003656576
 Epoch 26: f= 370.991, eps=0.003839405
 Epoch 27: f= 370.079, eps=0.004031375
 Epoch 28: f= 369.169, eps=0.004232944
 Epoch 29: f= 368.269, eps=0.004444591
 Epoch 30: f= 367.439, eps=0.004666820
 Epoch 31: f= 366.716, eps=0.004900161
 Epoch 32: f= 366.427, eps=0.005145169

Epoch	33:	f=	366.014,	eps=0.005402428
Epoch	34:	f=	366.514,	eps=0.002701214
Epoch	35:	f=	362.907,	eps=0.002836275
Epoch	36:	f=	362.399,	eps=0.002978088
Epoch	37:	f=	361.908,	eps=0.003126993
Epoch	38:	f=	361.412,	eps=0.003283342
Epoch	39:	f=	360.907,	eps=0.003447510
Epoch	40:	f=	360.396,	eps=0.003619885
Epoch	41:	f=	359.877,	eps=0.003800879
Epoch	42:	f=	359.354,	eps=0.003990923
Epoch	43:	f=	358.826,	eps=0.004190469
Epoch	44:	f=	358.297,	eps=0.004399993
Epoch	45:	f=	357.768,	eps=0.004619993
Epoch	46:	f=	357.244,	eps=0.004850992
Epoch	47:	f=	356.734,	eps=0.005093542
Epoch	48:	f=	356.263,	eps=0.005348219
Epoch	49:	f=	355.933,	eps=0.005615630
Epoch	50:	f=	355.907,	eps=0.005896411
Epoch	51:	f=	357.038,	eps=0.002948206
Epoch	52:	f=	354.510,	eps=0.003095616
Epoch	53:	f=	354.265,	eps=0.003250397
Epoch	54:	f=	354.042,	eps=0.003412917
Epoch	55:	f=	353.823,	eps=0.003583562
Epoch	56:	f=	353.608,	eps=0.003762741
Epoch	57:	f=	353.397,	eps=0.003950878
Epoch	58:	f=	353.192,	eps=0.004148421
Epoch	59:	f=	352.992,	eps=0.004355843
Epoch	60:	f=	352.799,	eps=0.004573635
Epoch	61:	f=	352.614,	eps=0.004802316
Epoch	62:	f=	352.439,	eps=0.005042432
Epoch	63:	f=	352.281,	eps=0.005294554
Epoch	64:	f=	352.172,	eps=0.005559282
Epoch	65:	f=	352.180,	eps=0.002779641
Epoch	66:	f=	351.903,	eps=0.002918623
Epoch	67:	f=	351.770,	eps=0.003064554
Epoch	68:	f=	351.684,	eps=0.003217782
Epoch	69:	f=	351.602,	eps=0.003378671
Epoch	70:	f=	351.520,	eps=0.003547604
Epoch	71:	f=	351.438,	eps=0.003724984
Epoch	72:	f=	351.355,	eps=0.003911234
Epoch	73:	f=	351.272,	eps=0.004106795
Epoch	74:	f=	351.188,	eps=0.004312135
Epoch	75:	f=	351.104,	eps=0.004527742
Epoch	76:	f=	351.019,	eps=0.004754129
Epoch	77:	f=	350.935,	eps=0.004991835
Epoch	78:	f=	350.852,	eps=0.005241427
Epoch	79:	f=	350.773,	eps=0.005503499
Epoch	80:	f=	350.711,	eps=0.005778674

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 Epoch 82: f= 350.979, eps=0.003033804
 Epoch 83: f= 350.479, eps=0.003185494
 Epoch 84: f= 350.425, eps=0.003344768
 Epoch 85: f= 350.378, eps=0.003512007
 Epoch 86: f= 350.333, eps=0.003687607
 Epoch 87: f= 350.287, eps=0.003871988
 Epoch 88: f= 350.241, eps=0.004065587
 Epoch 89: f= 350.194, eps=0.004268866
 Epoch 90: f= 350.146, eps=0.004482310
 Epoch 91: f= 350.098, eps=0.004706425
 Epoch 92: f= 350.050, eps=0.004941746
 Epoch 93: f= 350.003, eps=0.005188834
 Epoch 94: f= 349.960, eps=0.005448275
 Epoch 95: f= 349.932, eps=0.005720689
 Epoch 96: f= 349.968, eps=0.002860345
 Epoch 97: f= 349.826, eps=0.003003362
 Epoch 98: f= 349.794, eps=0.003153530
 Epoch 99: f= 349.766, eps=0.003311206
 Epoch 100: f= 349.738, eps=0.003476767
 Epoch 101: f= 349.710, eps=0.003650605
 Epoch 102: f= 349.681, eps=0.003833135
 Epoch 103: f= 349.652, eps=0.004024792
 Epoch 104: f= 349.621, eps=0.004226032
 Epoch 105: f= 349.590, eps=0.004437333
 Epoch 106: f= 349.558, eps=0.004659200
 Epoch 107: f= 349.526, eps=0.004892160
 Epoch 108: f= 349.493, eps=0.005136768
 Epoch 109: f= 349.459, eps=0.005393606
 Epoch 110: f= 349.425, eps=0.005663287
 Epoch 111: f= 349.393, eps=0.005946451
 Epoch 112: f= 349.367, eps=0.006243773
 Epoch 113: f= 349.370, eps=0.003121887
 Epoch 114: f= 349.317, eps=0.003277981
 Epoch 115: f= 349.286, eps=0.003441880
 Epoch 116: f= 349.265, eps=0.003613974
 Epoch 117: f= 349.244, eps=0.003794673
 Epoch 118: f= 349.224, eps=0.003984406
 Epoch 119: f= 349.203, eps=0.004183627
 Epoch 120: f= 349.182, eps=0.004392808
 Epoch 121: f= 349.161, eps=0.004612449
 Epoch 122: f= 349.139, eps=0.004843071
 Epoch 123: f= 349.117, eps=0.005085225
 Epoch 124: f= 349.096, eps=0.005339486
 Epoch 125: f= 349.079, eps=0.005606460
 Epoch 126: f= 349.077, eps=0.005886783
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Epoch 142: f= 348.800, eps=0.006119100
Epoch 143: f= 348.814, eps=0.003059550
Epoch 144: f= 348.770, eps=0.003212527
Epoch 145: f= 348.751, eps=0.003373154
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Epoch 157: f= 348.616, eps=0.006057699
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Epoch 165: f= 348.532, eps=0.004261896
Epoch 166: f= 348.523, eps=0.004474990
Epoch 167: f= 348.513, eps=0.004698740
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Epoch 169: f= 348.494, eps=0.005180361
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Epoch 172: f= 348.465, eps=0.005996915
Epoch 173: f= 348.461, eps=0.006296761
Epoch 174: f= 348.483, eps=0.003148380
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Epoch 180: f= 348.401, eps=0.004219131
Epoch 181: f= 348.393, eps=0.004430087
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Epoch 193: f= 348.313, eps=0.003788476
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Epoch 195: f= 348.302, eps=0.004176795
Epoch 196: f= 348.296, eps=0.004385635
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Epoch 270: f= 348.015, eps=0.003971405
Epoch 271: f= 348.013, eps=0.004169975
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Epoch 463: f= 347.855, eps=0.003159570
Epoch 464: f= 347.855, eps=0.003317549

Epoch 465: f= 347.855, eps=0.003483426
 Epoch 466: f= 347.855, eps=0.003657598
 Epoch 467: f= 347.855, eps=0.003840478
 Epoch 468: f= 347.855, eps=0.004032501
 Epoch 469: f= 347.854, eps=0.004234127
 Epoch 470: f= 347.854, eps=0.004445833
 Epoch 471: f= 347.854, eps=0.004668125
 Epoch 472: f= 347.854, eps=0.004901531
 Epoch 473: f= 347.854, eps=0.005146607
 Epoch 474: f= 347.854, eps=0.005403938
 Epoch 475: f= 347.854, eps=0.005674135
 Epoch 476: f= 347.853, eps=0.005957841
 Epoch 477: f= 347.853, eps=0.006255733
 Epoch 478: f= 347.853, eps=0.006568520
 Epoch 479: f= 347.853, eps=0.006896946
 Epoch 480: f= 347.853, eps=0.007241793
 Epoch 481: f= 347.852, eps=0.007603883
 Epoch 482: f= 347.852, eps=0.007984077
 Epoch 483: f= 347.854, eps=0.003992039
 Epoch 484: f= 347.853, eps=0.004191640
 Epoch 485: f= 347.853, eps=0.004401222
 Epoch 486: f= 347.853, eps=0.002200611
 Epoch 487: f= 347.852, eps=0.002310642
 Epoch 488: f= 347.851, eps=0.002426174
 Epoch 489: f= 347.851, eps=0.002547483
 Epoch 490: f= 347.851, eps=0.002674857
 Epoch 491: f= 347.851, eps=0.002808600
 Epoch 492: f= 347.851, eps=0.002949030
 Epoch 493: f= 347.851, eps=0.003096481
 Epoch 494: f= 347.851, eps=0.003251305
 Epoch 495: f= 347.851, eps=0.003413870
 Epoch 496: f= 347.851, eps=0.003584564
 Epoch 497: f= 347.851, eps=0.003763792
 Epoch 498: f= 347.851, eps=0.003951982
 Epoch 499: f= 347.851, eps=0.004149581
 Result after 500 epochs: f=347.85049245754726
 Epoch 0: f= 3470.639, eps=0.010000000
 Epoch 1: f= 1433.919, eps=0.010500000
 Epoch 2: f= 874.733, eps=0.011025000
 Epoch 3: f= 641.063, eps=0.011576250
 Epoch 4: f= 590.250, eps=0.012155063
 Epoch 5: f= 527.407, eps=0.012762816
 Epoch 6: f= 566.323, eps=0.006381408
 Epoch 7: f= 462.868, eps=0.006700478
 Epoch 8: f= 427.009, eps=0.007035502
 Epoch 9: f= 421.484, eps=0.007387277
 Epoch 10: f= 421.126, eps=0.007756641
 Epoch 11: f= 422.055, eps=0.003878321

Epoch 12:	f=	405.514,	eps=0.004072237
Epoch 13:	f=	400.657,	eps=0.004275848
Epoch 14:	f=	398.816,	eps=0.004489641
Epoch 15:	f=	396.854,	eps=0.004714123
Epoch 16:	f=	395.520,	eps=0.004949829
Epoch 17:	f=	393.421,	eps=0.005197320
Epoch 18:	f=	392.767,	eps=0.005457186
Epoch 19:	f=	390.296,	eps=0.005730046
Epoch 20:	f=	390.877,	eps=0.002865023
Epoch 21:	f=	384.085,	eps=0.003008274
Epoch 22:	f=	383.096,	eps=0.003158688
Epoch 23:	f=	382.137,	eps=0.003316622
Epoch 24:	f=	381.192,	eps=0.003482453
Epoch 25:	f=	380.247,	eps=0.003656576
Epoch 26:	f=	379.311,	eps=0.003839405
Epoch 27:	f=	378.385,	eps=0.004031375
Epoch 28:	f=	377.505,	eps=0.004232944
Epoch 29:	f=	376.692,	eps=0.004444591
Epoch 30:	f=	376.101,	eps=0.004666820
Epoch 31:	f=	375.638,	eps=0.004900161
Epoch 32:	f=	375.669,	eps=0.002450081
Epoch 33:	f=	373.114,	eps=0.002572585
Epoch 34:	f=	372.665,	eps=0.002701214
Epoch 35:	f=	372.214,	eps=0.002836275
Epoch 36:	f=	371.758,	eps=0.002978088
Epoch 37:	f=	371.299,	eps=0.003126993
Epoch 38:	f=	370.838,	eps=0.003283342
Epoch 39:	f=	370.375,	eps=0.003447510
Epoch 40:	f=	369.913,	eps=0.003619885
Epoch 41:	f=	369.454,	eps=0.003800879
Epoch 42:	f=	368.998,	eps=0.003990923
Epoch 43:	f=	368.549,	eps=0.004190469
Epoch 44:	f=	368.108,	eps=0.004399993
Epoch 45:	f=	367.678,	eps=0.004619993
Epoch 46:	f=	367.260,	eps=0.004850992
Epoch 47:	f=	366.858,	eps=0.005093542
Epoch 48:	f=	366.474,	eps=0.005348219
Epoch 49:	f=	366.114,	eps=0.005615630
Epoch 50:	f=	365.793,	eps=0.005896411
Epoch 51:	f=	365.585,	eps=0.006191232
Epoch 52:	f=	365.853,	eps=0.003095616
Epoch 53:	f=	365.317,	eps=0.003250397
Epoch 54:	f=	365.003,	eps=0.003412917
Epoch 55:	f=	364.855,	eps=0.003583562
Epoch 56:	f=	364.708,	eps=0.003762741
Epoch 57:	f=	364.599,	eps=0.003950878
Epoch 58:	f=	364.492,	eps=0.004148421
Epoch 59:	f=	364.449,	eps=0.004355843

Epoch 60: f= 364.426, eps=0.004573635
 Epoch 61: f= 364.637, eps=0.002286817
 Epoch 62: f= 363.958, eps=0.002401158
 Epoch 63: f= 363.900, eps=0.002521216
 Epoch 64: f= 363.841, eps=0.002647277
 Epoch 65: f= 363.781, eps=0.002779641
 Epoch 66: f= 363.720, eps=0.002918623
 Epoch 67: f= 363.659, eps=0.003064554
 Epoch 68: f= 363.597, eps=0.003217782
 Epoch 69: f= 363.534, eps=0.003378671
 Epoch 70: f= 363.470, eps=0.003547604
 Epoch 71: f= 363.406, eps=0.003724984
 Epoch 72: f= 363.341, eps=0.003911234
 Epoch 73: f= 363.275, eps=0.004106795
 Epoch 74: f= 363.209, eps=0.004312135
 Epoch 75: f= 363.143, eps=0.004527742
 Epoch 76: f= 363.077, eps=0.004754129
 Epoch 77: f= 363.010, eps=0.004991835
 Epoch 78: f= 362.944, eps=0.005241427
 Epoch 79: f= 362.877, eps=0.005503499
 Epoch 80: f= 362.811, eps=0.005778674
 Epoch 81: f= 362.745, eps=0.006067607
 Epoch 82: f= 362.679, eps=0.006370988
 Epoch 83: f= 362.615, eps=0.006689537
 Epoch 84: f= 362.556, eps=0.007024014
 Epoch 85: f= 362.540, eps=0.007375214
 Epoch 86: f= 362.878, eps=0.003687607
 Epoch 87: f= 362.824, eps=0.003871988
 Epoch 88: f= 362.634, eps=0.004065587
 Epoch 89: f= 362.719, eps=0.002032793
 Epoch 90: f= 362.317, eps=0.002134433
 Epoch 91: f= 362.299, eps=0.002241155
 Epoch 92: f= 362.283, eps=0.002353213
 Epoch 93: f= 362.266, eps=0.002470873
 Epoch 94: f= 362.249, eps=0.002594417
 Epoch 95: f= 362.231, eps=0.002724138
 Epoch 96: f= 362.213, eps=0.002860345
 Epoch 97: f= 362.195, eps=0.003003362
 Epoch 98: f= 362.176, eps=0.003153530
 Epoch 99: f= 362.156, eps=0.003311206
 Epoch 100: f= 362.136, eps=0.003476767
 Epoch 101: f= 362.115, eps=0.003650605
 Epoch 102: f= 362.094, eps=0.003833135
 Epoch 103: f= 362.072, eps=0.004024792
 Epoch 104: f= 362.050, eps=0.004226032
 Epoch 105: f= 362.028, eps=0.004437333
 Epoch 106: f= 362.005, eps=0.004659200
 Epoch 107: f= 361.982, eps=0.004892160

Epoch 108: f= 361.958, eps=0.005136768
Epoch 109: f= 361.934, eps=0.005393606
Epoch 110: f= 361.909, eps=0.005663287
Epoch 111: f= 361.885, eps=0.005946451
Epoch 112: f= 361.860, eps=0.006243773
Epoch 113: f= 361.835, eps=0.006555962
Epoch 114: f= 361.810, eps=0.006883760
Epoch 115: f= 361.784, eps=0.007227948
Epoch 116: f= 361.759, eps=0.007589346
Epoch 117: f= 361.736, eps=0.007968813
Epoch 118: f= 361.742, eps=0.003984406
Epoch 119: f= 361.735, eps=0.004183627
Epoch 120: f= 361.748, eps=0.002091813
Epoch 121: f= 361.677, eps=0.002196404
Epoch 122: f= 361.670, eps=0.002306224
Epoch 123: f= 361.664, eps=0.002421535
Epoch 124: f= 361.657, eps=0.002542612
Epoch 125: f= 361.650, eps=0.002669743
Epoch 126: f= 361.642, eps=0.002803230
Epoch 127: f= 361.635, eps=0.002943392
Epoch 128: f= 361.627, eps=0.003090561
Epoch 129: f= 361.619, eps=0.003245089
Epoch 130: f= 361.611, eps=0.003407344
Epoch 131: f= 361.602, eps=0.003577711
Epoch 132: f= 361.594, eps=0.003756596
Epoch 133: f= 361.585, eps=0.003944426
Epoch 134: f= 361.575, eps=0.004141647
Epoch 135: f= 361.566, eps=0.004348730
Epoch 136: f= 361.556, eps=0.004566166
Epoch 137: f= 361.546, eps=0.004794475
Epoch 138: f= 361.536, eps=0.005034198
Epoch 139: f= 361.526, eps=0.005285908
Epoch 140: f= 361.515, eps=0.005550204
Epoch 141: f= 361.504, eps=0.005827714
Epoch 142: f= 361.493, eps=0.006119100
Epoch 143: f= 361.482, eps=0.006425055
Epoch 144: f= 361.471, eps=0.006746307
Epoch 145: f= 361.460, eps=0.007083623
Epoch 146: f= 361.448, eps=0.007437804
Epoch 147: f= 361.437, eps=0.007809694
Epoch 148: f= 361.431, eps=0.008200179
Epoch 149: f= 361.480, eps=0.004100089
Epoch 150: f= 361.508, eps=0.002050045
Epoch 151: f= 361.405, eps=0.002152547
Epoch 152: f= 361.402, eps=0.002260174
Epoch 153: f= 361.399, eps=0.002373183
Epoch 154: f= 361.396, eps=0.002491842
Epoch 155: f= 361.392, eps=0.002616434

Epoch 156: f= 361.389, eps=0.002747256
Epoch 157: f= 361.386, eps=0.002884619
Epoch 158: f= 361.382, eps=0.003028850
Epoch 159: f= 361.378, eps=0.003180292
Epoch 160: f= 361.375, eps=0.003339307
Epoch 161: f= 361.371, eps=0.003506272
Epoch 162: f= 361.367, eps=0.003681586
Epoch 163: f= 361.362, eps=0.003865665
Epoch 164: f= 361.358, eps=0.004058948
Epoch 165: f= 361.354, eps=0.004261896
Epoch 166: f= 361.349, eps=0.004474990
Epoch 167: f= 361.345, eps=0.004698740
Epoch 168: f= 361.340, eps=0.004933677
Epoch 169: f= 361.335, eps=0.005180361
Epoch 170: f= 361.330, eps=0.005439379
Epoch 171: f= 361.325, eps=0.005711348
Epoch 172: f= 361.320, eps=0.005996915
Epoch 173: f= 361.314, eps=0.006296761
Epoch 174: f= 361.309, eps=0.006611599
Epoch 175: f= 361.303, eps=0.006942179
Epoch 176: f= 361.298, eps=0.007289288
Epoch 177: f= 361.292, eps=0.007653752
Epoch 178: f= 361.287, eps=0.008036440
Epoch 179: f= 361.281, eps=0.008438262
Epoch 180: f= 361.279, eps=0.008860175
Epoch 181: f= 361.320, eps=0.004430087
Epoch 182: f= 361.366, eps=0.002215044
Epoch 183: f= 361.266, eps=0.002325796
Epoch 184: f= 361.264, eps=0.002442086
Epoch 185: f= 361.262, eps=0.002564190
Epoch 186: f= 361.261, eps=0.002692399
Epoch 187: f= 361.259, eps=0.002827019
Epoch 188: f= 361.258, eps=0.002968370
Epoch 189: f= 361.256, eps=0.003116789
Epoch 190: f= 361.254, eps=0.003272628
Epoch 191: f= 361.252, eps=0.003436260
Epoch 192: f= 361.251, eps=0.003608073
Epoch 193: f= 361.249, eps=0.003788476
Epoch 194: f= 361.247, eps=0.003977900
Epoch 195: f= 361.245, eps=0.004176795
Epoch 196: f= 361.242, eps=0.004385635
Epoch 197: f= 361.240, eps=0.004604917
Epoch 198: f= 361.238, eps=0.004835163
Epoch 199: f= 361.236, eps=0.005076921
Epoch 200: f= 361.234, eps=0.005330767
Epoch 201: f= 361.231, eps=0.005597305
Epoch 202: f= 361.229, eps=0.005877170
Epoch 203: f= 361.226, eps=0.006171029

Epoch 204: f= 361.224, eps=0.006479580
Epoch 205: f= 361.221, eps=0.006803559
Epoch 206: f= 361.220, eps=0.007143737
Epoch 207: f= 361.230, eps=0.003571869
Epoch 208: f= 361.227, eps=0.003750462
Epoch 209: f= 361.225, eps=0.003937985
Epoch 210: f= 361.227, eps=0.001968993
Epoch 211: f= 361.211, eps=0.002067442
Epoch 212: f= 361.211, eps=0.002170814
Epoch 213: f= 361.210, eps=0.002279355
Epoch 214: f= 361.209, eps=0.002393323
Epoch 215: f= 361.208, eps=0.002512989
Epoch 216: f= 361.207, eps=0.002638638
Epoch 217: f= 361.207, eps=0.002770570
Epoch 218: f= 361.206, eps=0.002909099
Epoch 219: f= 361.205, eps=0.003054554
Epoch 220: f= 361.204, eps=0.003207282
Epoch 221: f= 361.203, eps=0.003367646
Epoch 222: f= 361.202, eps=0.003536028
Epoch 223: f= 361.201, eps=0.003712829
Epoch 224: f= 361.200, eps=0.003898471
Epoch 225: f= 361.199, eps=0.004093394
Epoch 226: f= 361.198, eps=0.004298064
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Epoch 228: f= 361.195, eps=0.004738616
Epoch 229: f= 361.194, eps=0.004975546
Epoch 230: f= 361.193, eps=0.005224324
Epoch 231: f= 361.192, eps=0.005485540
Epoch 232: f= 361.190, eps=0.005759817
Epoch 233: f= 361.189, eps=0.006047808
Epoch 234: f= 361.188, eps=0.006350198
Epoch 235: f= 361.186, eps=0.006667708
Epoch 236: f= 361.185, eps=0.007001093
Epoch 237: f= 361.183, eps=0.007351148
Epoch 238: f= 361.182, eps=0.007718705
Epoch 239: f= 361.180, eps=0.008104641
Epoch 240: f= 361.179, eps=0.008509873
Epoch 241: f= 361.177, eps=0.008935366
Epoch 242: f= 361.177, eps=0.009382135
Epoch 243: f= 361.187, eps=0.004691067
Epoch 244: f= 361.204, eps=0.002345534
Epoch 245: f= 361.175, eps=0.002462810
Epoch 246: f= 361.173, eps=0.002585951
Epoch 247: f= 361.173, eps=0.002715248
Epoch 248: f= 361.172, eps=0.002851011
Epoch 249: f= 361.172, eps=0.002993561
Epoch 250: f= 361.171, eps=0.003143239
Epoch 251: f= 361.171, eps=0.003300401

Epoch 252: f= 361.170, eps=0.003465421
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Epoch 255: f= 361.169, eps=0.004011659
Epoch 256: f= 361.168, eps=0.004212241
Epoch 257: f= 361.168, eps=0.004422854
Epoch 258: f= 361.167, eps=0.004643996
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Epoch 260: f= 361.166, eps=0.005120006
Epoch 261: f= 361.166, eps=0.005376006
Epoch 262: f= 361.165, eps=0.005644806
Epoch 263: f= 361.164, eps=0.005927047
Epoch 264: f= 361.164, eps=0.006223399
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Epoch 298: f= 361.153, eps=0.007413533
Epoch 299: f= 361.154, eps=0.003706767

Epoch 300: f= 361.154, eps=0.003892105
Epoch 301: f= 361.154, eps=0.004086710
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Epoch 303: f= 361.152, eps=0.002145523
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Epoch 319: f= 361.150, eps=0.004683407
Epoch 320: f= 361.150, eps=0.004917578
Epoch 321: f= 361.149, eps=0.005163456
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Epoch 323: f= 361.149, eps=0.005692711
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Epoch 329: f= 361.148, eps=0.007628777
Epoch 330: f= 361.148, eps=0.008010216
Epoch 331: f= 361.147, eps=0.008410726
Epoch 332: f= 361.148, eps=0.004205363
Epoch 333: f= 361.149, eps=0.002102682
Epoch 334: f= 361.147, eps=0.002207816
Epoch 335: f= 361.147, eps=0.002318206
Epoch 336: f= 361.147, eps=0.002434117
Epoch 337: f= 361.147, eps=0.002555823
Epoch 338: f= 361.147, eps=0.002683614
Epoch 339: f= 361.147, eps=0.002817794
Epoch 340: f= 361.147, eps=0.002958684
Epoch 341: f= 361.147, eps=0.003106618
Epoch 342: f= 361.147, eps=0.003261949
Epoch 343: f= 361.146, eps=0.003425047
Epoch 344: f= 361.146, eps=0.003596299
Epoch 345: f= 361.146, eps=0.003776114
Epoch 346: f= 361.146, eps=0.003964920
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Epoch 348: f= 361.146, eps=0.004371324
Epoch 349: f= 361.146, eps=0.004589890
Epoch 350: f= 361.146, eps=0.004819385
Epoch 351: f= 361.146, eps=0.005060354
Epoch 352: f= 361.146, eps=0.005313372
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Epoch 363: f= 361.145, eps=0.002060696
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Epoch 365: f= 361.145, eps=0.002271917
Epoch 366: f= 361.145, eps=0.002385513
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Epoch 465: f= 361.142, eps=0.003483426
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Epoch 467: f= 361.142, eps=0.003840478
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Epoch 471: f= 361.142, eps=0.004668125
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Epoch 480: f= 361.142, eps=0.003448473
Epoch 481: f= 361.142, eps=0.003620897
Epoch 482: f= 361.142, eps=0.003801941
Epoch 483: f= 361.142, eps=0.003992039
Epoch 484: f= 361.142, eps=0.004191640
Epoch 485: f= 361.142, eps=0.004401222
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Epoch 487: f= 361.142, eps=0.002310642
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Epoch 489: f= 361.142, eps=0.002547483
Epoch 490: f= 361.142, eps=0.002674857
Epoch 491: f= 361.142, eps=0.002808600

Epoch 492: f= 361.142, eps=0.002949030
 Epoch 493: f= 361.142, eps=0.003096481
 Epoch 494: f= 361.142, eps=0.003251305
 Epoch 495: f= 361.142, eps=0.003413870
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 Epoch 497: f= 361.142, eps=0.003763792
 Epoch 498: f= 361.142, eps=0.003951982
 Epoch 499: f= 361.142, eps=0.004149581
 Result after 500 epochs: f=361.1419871051869
 Epoch 0: f= 3504.201, eps=0.010000000
 Epoch 1: f= 1484.232, eps=0.010500000
 Epoch 2: f= 901.263, eps=0.011025000
 Epoch 3: f= 661.272, eps=0.011576250
 Epoch 4: f= 608.524, eps=0.012155063
 Epoch 5: f= 544.888, eps=0.012762816
 Epoch 6: f= 592.502, eps=0.006381408
 Epoch 7: f= 474.161, eps=0.006700478
 Epoch 8: f= 435.176, eps=0.007035502
 Epoch 9: f= 430.963, eps=0.007387277
 Epoch 10: f= 433.337, eps=0.003693639
 Epoch 11: f= 416.932, eps=0.003878321
 Epoch 12: f= 412.242, eps=0.004072237
 Epoch 13: f= 409.856, eps=0.004275848
 Epoch 14: f= 407.274, eps=0.004489641
 Epoch 15: f= 405.557, eps=0.004714123
 Epoch 16: f= 402.987, eps=0.004949829
 Epoch 17: f= 402.050, eps=0.005197320
 Epoch 18: f= 399.100, eps=0.005457186
 Epoch 19: f= 399.350, eps=0.002728593
 Epoch 20: f= 393.180, eps=0.002865023
 Epoch 21: f= 392.040, eps=0.003008274
 Epoch 22: f= 390.977, eps=0.003158688
 Epoch 23: f= 389.934, eps=0.003316622
 Epoch 24: f= 388.903, eps=0.003482453
 Epoch 25: f= 387.884, eps=0.003656576
 Epoch 26: f= 386.883, eps=0.003839405
 Epoch 27: f= 385.917, eps=0.004031375
 Epoch 28: f= 385.013, eps=0.004232944
 Epoch 29: f= 384.250, eps=0.004444591
 Epoch 30: f= 383.712, eps=0.004666820
 Epoch 31: f= 383.535, eps=0.004900161
 Epoch 32: f= 383.475, eps=0.005145169
 Epoch 33: f= 383.201, eps=0.005402428
 Epoch 34: f= 383.690, eps=0.002701214
 Epoch 35: f= 378.989, eps=0.002836275
 Epoch 36: f= 378.595, eps=0.002978088
 Epoch 37: f= 378.216, eps=0.003126993
 Epoch 38: f= 377.844, eps=0.003283342

Epoch 39: f= 377.479, eps=0.003447510
 Epoch 40: f= 377.121, eps=0.003619885
 Epoch 41: f= 376.772, eps=0.003800879
 Epoch 42: f= 376.434, eps=0.003990923
 Epoch 43: f= 376.112, eps=0.004190469
 Epoch 44: f= 375.812, eps=0.004399993
 Epoch 45: f= 375.554, eps=0.004619993
 Epoch 46: f= 375.400, eps=0.004850992
 Epoch 47: f= 375.486, eps=0.002425496
 Epoch 48: f= 374.865, eps=0.002546771
 Epoch 49: f= 374.692, eps=0.002674109
 Epoch 50: f= 374.561, eps=0.002807815
 Epoch 51: f= 374.438, eps=0.002948206
 Epoch 52: f= 374.317, eps=0.003095616
 Epoch 53: f= 374.198, eps=0.003250397
 Epoch 54: f= 374.079, eps=0.003412917
 Epoch 55: f= 373.963, eps=0.003583562
 Epoch 56: f= 373.847, eps=0.003762741
 Epoch 57: f= 373.734, eps=0.003950878
 Epoch 58: f= 373.621, eps=0.004148421
 Epoch 59: f= 373.512, eps=0.004355843
 Epoch 60: f= 373.405, eps=0.004573635
 Epoch 61: f= 373.306, eps=0.004802316
 Epoch 62: f= 373.229, eps=0.005042432
 Epoch 63: f= 373.227, eps=0.005294554
 Epoch 64: f= 373.538, eps=0.002647277
 Epoch 65: f= 372.991, eps=0.002779641
 Epoch 66: f= 372.908, eps=0.002918623
 Epoch 67: f= 372.846, eps=0.003064554
 Epoch 68: f= 372.793, eps=0.003217782
 Epoch 69: f= 372.741, eps=0.003378671
 Epoch 70: f= 372.690, eps=0.003547604
 Epoch 71: f= 372.639, eps=0.003724984
 Epoch 72: f= 372.589, eps=0.003911234
 Epoch 73: f= 372.541, eps=0.004106795
 Epoch 74: f= 372.496, eps=0.004312135
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 Epoch 83: f= 372.168, eps=0.003185494
 Epoch 84: f= 372.140, eps=0.003344768
 Epoch 85: f= 372.112, eps=0.003512007
 Epoch 86: f= 372.083, eps=0.003687607

Epoch 87: f= 372.054, eps=0.003871988
 Epoch 88: f= 372.024, eps=0.004065587
 Epoch 89: f= 371.994, eps=0.004268866
 Epoch 90: f= 371.964, eps=0.004482310
 Epoch 91: f= 371.935, eps=0.004706425
 Epoch 92: f= 371.906, eps=0.004941746
 Epoch 93: f= 371.884, eps=0.005188834
 Epoch 94: f= 371.885, eps=0.002594417
 Epoch 95: f= 371.836, eps=0.002724138
 Epoch 96: f= 371.815, eps=0.002860345
 Epoch 97: f= 371.798, eps=0.003003362
 Epoch 98: f= 371.781, eps=0.003153530
 Epoch 99: f= 371.765, eps=0.003311206
 Epoch 100: f= 371.748, eps=0.003476767
 Epoch 101: f= 371.732, eps=0.003650605
 Epoch 102: f= 371.715, eps=0.003833135
 Epoch 103: f= 371.698, eps=0.004024792
 Epoch 104: f= 371.680, eps=0.004226032
 Epoch 105: f= 371.663, eps=0.004437333
 Epoch 106: f= 371.648, eps=0.004659200
 Epoch 107: f= 371.638, eps=0.004892160
 Epoch 108: f= 371.648, eps=0.002446080
 Epoch 109: f= 371.604, eps=0.002568384
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Epoch 136: f= 371.365, eps=0.004566166
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Epoch 251: f= 371.149, eps=0.003300401
Epoch 252: f= 371.148, eps=0.003465421
Epoch 253: f= 371.148, eps=0.003638693
Epoch 254: f= 371.148, eps=0.001819346
Epoch 255: f= 371.146, eps=0.001910314
Epoch 256: f= 371.146, eps=0.002005829
Epoch 257: f= 371.146, eps=0.002106121
Epoch 258: f= 371.146, eps=0.002211427
Epoch 259: f= 371.146, eps=0.002321998
Epoch 260: f= 371.146, eps=0.002438098
Epoch 261: f= 371.145, eps=0.002560003
Epoch 262: f= 371.145, eps=0.002688003
Epoch 263: f= 371.145, eps=0.002822403
Epoch 264: f= 371.145, eps=0.002963523
Epoch 265: f= 371.145, eps=0.003111700
Epoch 266: f= 371.145, eps=0.003267285
Epoch 267: f= 371.145, eps=0.003430649
Epoch 268: f= 371.145, eps=0.003602181
Epoch 269: f= 371.144, eps=0.003782290
Epoch 270: f= 371.144, eps=0.003971405
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Epoch 283: f= 371.142, eps=0.007488676
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Epoch 294: f= 371.141, eps=0.002904349
Epoch 295: f= 371.141, eps=0.003049566
Epoch 296: f= 371.141, eps=0.003202044
Epoch 297: f= 371.141, eps=0.003362147
Epoch 298: f= 371.141, eps=0.003530254
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Epoch 324: f= 371.140, eps=0.002846355
Epoch 325: f= 371.140, eps=0.002988673
Epoch 326: f= 371.140, eps=0.003138107

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Epoch 350: f= 371.139, eps=0.002294945
Epoch 351: f= 371.139, eps=0.002409692
Epoch 352: f= 371.139, eps=0.002530177
Epoch 353: f= 371.139, eps=0.002656686
Epoch 354: f= 371.139, eps=0.002789520
Epoch 355: f= 371.139, eps=0.002928996
Epoch 356: f= 371.139, eps=0.003075446
Epoch 357: f= 371.139, eps=0.003229218
Epoch 358: f= 371.139, eps=0.003390679
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Epoch 362: f= 371.139, eps=0.004121392
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Epoch 364: f= 371.139, eps=0.004543834
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Epoch 366: f= 371.139, eps=0.005009577
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Epoch 371: f= 371.139, eps=0.006393631
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Epoch 374: f= 371.139, eps=0.007401427

Epoch 375: f= 371.139, eps=0.007771499
Epoch 376: f= 371.139, eps=0.008160074
Epoch 377: f= 371.139, eps=0.004080037
Epoch 378: f= 371.139, eps=0.002040018
Epoch 379: f= 371.139, eps=0.002142019
Epoch 380: f= 371.139, eps=0.002249120
Epoch 381: f= 371.139, eps=0.002361576
Epoch 382: f= 371.139, eps=0.002479655
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Epoch 403: f= 371.139, eps=0.003289632
Epoch 404: f= 371.139, eps=0.003454113
Epoch 405: f= 371.139, eps=0.003626819
Epoch 406: f= 371.139, eps=0.003808160
Epoch 407: f= 371.139, eps=0.001904080
Epoch 408: f= 371.139, eps=0.001999284
Epoch 409: f= 371.139, eps=0.002099248
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Epoch 415: f= 371.139, eps=0.002813193
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Epoch 426: f= 371.139, eps=0.004811515
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Epoch 428: f= 371.139, eps=0.005304695
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Epoch 430: f= 371.139, eps=0.005848427
Epoch 431: f= 371.139, eps=0.006140848
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Epoch 434: f= 371.139, eps=0.007108799
Epoch 435: f= 371.139, eps=0.007464239
Epoch 436: f= 371.139, eps=0.007837451
Epoch 437: f= 371.139, eps=0.003918726
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Epoch 442: f= 371.139, eps=0.002381618
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Epoch 451: f= 371.139, eps=0.003694671
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Epoch 453: f= 371.139, eps=0.004073375
Epoch 454: f= 371.139, eps=0.004277043
Epoch 455: f= 371.139, eps=0.004490895
Epoch 456: f= 371.139, eps=0.004715440
Epoch 457: f= 371.139, eps=0.004951212
Epoch 458: f= 371.139, eps=0.005198773
Epoch 459: f= 371.139, eps=0.005458711
Epoch 460: f= 371.139, eps=0.005731647
Epoch 461: f= 371.139, eps=0.006018229
Epoch 462: f= 371.139, eps=0.006319141
Epoch 463: f= 371.139, eps=0.006635098
Epoch 464: f= 371.139, eps=0.006966853
Epoch 465: f= 371.139, eps=0.007315195
Epoch 466: f= 371.139, eps=0.003657598
Epoch 467: f= 371.139, eps=0.001828799
Epoch 468: f= 371.139, eps=0.001920239
Epoch 469: f= 371.139, eps=0.002016251
Epoch 470: f= 371.139, eps=0.002117063

Epoch 471: f= 371.139, eps=0.002222916
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 Epoch 474: f= 371.139, eps=0.002573304
 Epoch 475: f= 371.139, eps=0.002701969
 Epoch 476: f= 371.139, eps=0.002837067
 Epoch 477: f= 371.139, eps=0.002978921
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 Epoch 479: f= 371.139, eps=0.003284260
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 Epoch 484: f= 371.139, eps=0.004191640
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 Epoch 486: f= 371.139, eps=0.004621284
 Epoch 487: f= 371.139, eps=0.004852348
 Epoch 488: f= 371.139, eps=0.005094965
 Epoch 489: f= 371.139, eps=0.005349713
 Epoch 490: f= 371.139, eps=0.005617199
 Epoch 491: f= 371.139, eps=0.005898059
 Epoch 492: f= 371.139, eps=0.006192962
 Epoch 493: f= 371.139, eps=0.006502610
 Epoch 494: f= 371.139, eps=0.006827741
 Epoch 495: f= 371.139, eps=0.007169128
 Epoch 496: f= 371.139, eps=0.007527584
 Epoch 497: f= 371.139, eps=0.007903963
 Epoch 498: f= 371.139, eps=0.008299161
 Epoch 499: f= 371.139, eps=0.004149581
 Result after 500 epochs: f=371.1389275935148
 Epoch 0: f= 3537.762, eps=0.010000000
 Epoch 1: f= 1533.962, eps=0.010500000
 Epoch 2: f= 925.611, eps=0.011025000
 Epoch 3: f= 678.698, eps=0.011576250
 Epoch 4: f= 623.594, eps=0.012155063
 Epoch 5: f= 559.072, eps=0.012762816
 Epoch 6: f= 618.976, eps=0.006381408
 Epoch 7: f= 482.920, eps=0.006700478
 Epoch 8: f= 440.697, eps=0.007035502
 Epoch 9: f= 437.285, eps=0.007387277
 Epoch 10: f= 441.657, eps=0.003693639
 Epoch 11: f= 422.980, eps=0.003878321
 Epoch 12: f= 416.092, eps=0.004072237
 Epoch 13: f= 413.571, eps=0.004275848
 Epoch 14: f= 411.182, eps=0.004489641
 Epoch 15: f= 409.539, eps=0.004714123
 Epoch 16: f= 406.994, eps=0.004949829
 Epoch 17: f= 406.279, eps=0.005197320

Epoch 18: f= 403.037, eps=0.005457186
 Epoch 19: f= 403.756, eps=0.002728593
 Epoch 20: f= 397.360, eps=0.002865023
 Epoch 21: f= 396.197, eps=0.003008274
 Epoch 22: f= 395.177, eps=0.003158688
 Epoch 23: f= 394.192, eps=0.003316622
 Epoch 24: f= 393.236, eps=0.003482453
 Epoch 25: f= 392.308, eps=0.003656576
 Epoch 26: f= 391.420, eps=0.003839405
 Epoch 27: f= 390.591, eps=0.004031375
 Epoch 28: f= 389.875, eps=0.004232944
 Epoch 29: f= 389.344, eps=0.004444591
 Epoch 30: f= 389.133, eps=0.004666820
 Epoch 31: f= 389.036, eps=0.004900161
 Epoch 32: f= 389.384, eps=0.002450081
 Epoch 33: f= 386.092, eps=0.002572585
 Epoch 34: f= 385.751, eps=0.002701214
 Epoch 35: f= 385.424, eps=0.002836275
 Epoch 36: f= 385.103, eps=0.002978088
 Epoch 37: f= 384.788, eps=0.003126993
 Epoch 38: f= 384.481, eps=0.003283342
 Epoch 39: f= 384.182, eps=0.003447510
 Epoch 40: f= 383.892, eps=0.003619885
 Epoch 41: f= 383.613, eps=0.003800879
 Epoch 42: f= 383.346, eps=0.003990923
 Epoch 43: f= 383.092, eps=0.004190469
 Epoch 44: f= 382.852, eps=0.004399993
 Epoch 45: f= 382.630, eps=0.004619993
 Epoch 46: f= 382.442, eps=0.004850992
 Epoch 47: f= 382.347, eps=0.005093542
 Epoch 48: f= 382.579, eps=0.002546771
 Epoch 49: f= 381.981, eps=0.002674109
 Epoch 50: f= 381.840, eps=0.002807815
 Epoch 51: f= 381.735, eps=0.002948206
 Epoch 52: f= 381.641, eps=0.003095616
 Epoch 53: f= 381.551, eps=0.003250397
 Epoch 54: f= 381.462, eps=0.003412917
 Epoch 55: f= 381.374, eps=0.003583562
 Epoch 56: f= 381.289, eps=0.003762741
 Epoch 57: f= 381.206, eps=0.003950878
 Epoch 58: f= 381.129, eps=0.004148421
 Epoch 59: f= 381.064, eps=0.004355843
 Epoch 60: f= 381.034, eps=0.004573635
 Epoch 61: f= 381.107, eps=0.002286817
 Epoch 62: f= 380.851, eps=0.002401158
 Epoch 63: f= 380.792, eps=0.002521216
 Epoch 64: f= 380.749, eps=0.002647277
 Epoch 65: f= 380.709, eps=0.002779641

Epoch 66: f= 380.668, eps=0.002918623
 Epoch 67: f= 380.627, eps=0.003064554
 Epoch 68: f= 380.586, eps=0.003217782
 Epoch 69: f= 380.545, eps=0.003378671
 Epoch 70: f= 380.503, eps=0.003547604
 Epoch 71: f= 380.461, eps=0.003724984
 Epoch 72: f= 380.420, eps=0.003911234
 Epoch 73: f= 380.378, eps=0.004106795
 Epoch 74: f= 380.336, eps=0.004312135
 Epoch 75: f= 380.295, eps=0.004527742
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 Epoch 86: f= 379.996, eps=0.003687607
 Epoch 87: f= 379.977, eps=0.003871988
 Epoch 88: f= 379.960, eps=0.004065587
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 Epoch 91: f= 379.901, eps=0.002241155
 Epoch 92: f= 379.888, eps=0.002353213
 Epoch 93: f= 379.877, eps=0.002470873
 Epoch 94: f= 379.866, eps=0.002594417
 Epoch 95: f= 379.855, eps=0.002724138
 Epoch 96: f= 379.844, eps=0.002860345
 Epoch 97: f= 379.832, eps=0.003003362
 Epoch 98: f= 379.821, eps=0.003153530
 Epoch 99: f= 379.809, eps=0.003311206
 Epoch 100: f= 379.796, eps=0.003476767
 Epoch 101: f= 379.784, eps=0.003650605
 Epoch 102: f= 379.772, eps=0.003833135
 Epoch 103: f= 379.759, eps=0.004024792
 Epoch 104: f= 379.747, eps=0.004226032
 Epoch 105: f= 379.734, eps=0.004437333
 Epoch 106: f= 379.721, eps=0.004659200
 Epoch 107: f= 379.709, eps=0.004892160
 Epoch 108: f= 379.696, eps=0.005136768
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 Epoch 110: f= 379.673, eps=0.005663287
 Epoch 111: f= 379.669, eps=0.005946451
 Epoch 112: f= 379.713, eps=0.002973225
 Epoch 113: f= 379.676, eps=0.003121887

Epoch 114: f= 379.660, eps=0.003277981
Epoch 115: f= 379.650, eps=0.003441880
Epoch 116: f= 379.646, eps=0.003613974
Epoch 117: f= 379.647, eps=0.001806987
Epoch 118: f= 379.612, eps=0.001897336
Epoch 119: f= 379.609, eps=0.001992203
Epoch 120: f= 379.606, eps=0.002091813
Epoch 121: f= 379.603, eps=0.002196404
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Epoch 123: f= 379.596, eps=0.002421535
Epoch 124: f= 379.592, eps=0.002542612
Epoch 125: f= 379.589, eps=0.002669743
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Epoch 135: f= 379.548, eps=0.004348730
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Epoch 141: f= 379.522, eps=0.005827714
Epoch 142: f= 379.517, eps=0.006119100
Epoch 143: f= 379.513, eps=0.006425055
Epoch 144: f= 379.509, eps=0.006746307
Epoch 145: f= 379.504, eps=0.007083623
Epoch 146: f= 379.500, eps=0.007437804
Epoch 147: f= 379.498, eps=0.007809694
Epoch 148: f= 379.508, eps=0.003904847
Epoch 149: f= 379.518, eps=0.001952423
Epoch 150: f= 379.490, eps=0.002050045
Epoch 151: f= 379.489, eps=0.002152547
Epoch 152: f= 379.488, eps=0.002260174
Epoch 153: f= 379.487, eps=0.002373183
Epoch 154: f= 379.486, eps=0.002491842
Epoch 155: f= 379.485, eps=0.002616434
Epoch 156: f= 379.484, eps=0.002747256
Epoch 157: f= 379.483, eps=0.002884619
Epoch 158: f= 379.482, eps=0.003028850
Epoch 159: f= 379.481, eps=0.003180292
Epoch 160: f= 379.479, eps=0.003339307
Epoch 161: f= 379.478, eps=0.003506272

Epoch 162: f= 379.477, eps=0.003681586
Epoch 163: f= 379.476, eps=0.003865665
Epoch 164: f= 379.475, eps=0.004058948
Epoch 165: f= 379.474, eps=0.004261896
Epoch 166: f= 379.472, eps=0.004474990
Epoch 167: f= 379.471, eps=0.004698740
Epoch 168: f= 379.470, eps=0.004933677
Epoch 169: f= 379.469, eps=0.005180361
Epoch 170: f= 379.467, eps=0.005439379
Epoch 171: f= 379.466, eps=0.005711348
Epoch 172: f= 379.465, eps=0.005996915
Epoch 173: f= 379.464, eps=0.006296761
Epoch 174: f= 379.463, eps=0.006611599
Epoch 175: f= 379.469, eps=0.003305799
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Epoch 177: f= 379.468, eps=0.001735545
Epoch 178: f= 379.460, eps=0.001822322
Epoch 179: f= 379.460, eps=0.001913438
Epoch 180: f= 379.459, eps=0.002009110
Epoch 181: f= 379.459, eps=0.002109565
Epoch 182: f= 379.459, eps=0.002215044
Epoch 183: f= 379.458, eps=0.002325796
Epoch 184: f= 379.458, eps=0.002442086
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Epoch 186: f= 379.457, eps=0.002692399
Epoch 187: f= 379.457, eps=0.002827019
Epoch 188: f= 379.457, eps=0.002968370
Epoch 189: f= 379.456, eps=0.003116789
Epoch 190: f= 379.456, eps=0.003272628
Epoch 191: f= 379.455, eps=0.003436260
Epoch 192: f= 379.455, eps=0.003608073
Epoch 193: f= 379.455, eps=0.003788476
Epoch 194: f= 379.454, eps=0.003977900
Epoch 195: f= 379.454, eps=0.004176795
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Epoch 209: f= 379.448, eps=0.008269769

Epoch 210: f= 379.448, eps=0.008683257
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Epoch 212: f= 379.461, eps=0.002170814
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Epoch 214: f= 379.447, eps=0.002393323
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Epoch 236: f= 379.445, eps=0.003333854
Epoch 237: f= 379.445, eps=0.003500547
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Epoch 242: f= 379.445, eps=0.002127468
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Epoch 251: f= 379.444, eps=0.003300401
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Epoch 256: f= 379.444, eps=0.004212241
Epoch 257: f= 379.444, eps=0.004422854

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Epoch 270: f= 379.444, eps=0.001891145
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Epoch 272: f= 379.444, eps=0.002084987
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Epoch 274: f= 379.444, eps=0.002298699
Epoch 275: f= 379.444, eps=0.002413634
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Epoch 278: f= 379.444, eps=0.002794083
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Epoch 282: f= 379.444, eps=0.003396225
Epoch 283: f= 379.444, eps=0.003566036
Epoch 284: f= 379.444, eps=0.003744338
Epoch 285: f= 379.444, eps=0.003931555
Epoch 286: f= 379.444, eps=0.004128133
Epoch 287: f= 379.444, eps=0.004334539
Epoch 288: f= 379.444, eps=0.004551266
Epoch 289: f= 379.444, eps=0.004778830
Epoch 290: f= 379.444, eps=0.005017771
Epoch 291: f= 379.444, eps=0.005268660
Epoch 292: f= 379.444, eps=0.005532093
Epoch 293: f= 379.444, eps=0.005808697
Epoch 294: f= 379.444, eps=0.006099132
Epoch 295: f= 379.444, eps=0.006404089
Epoch 296: f= 379.444, eps=0.006724293
Epoch 297: f= 379.444, eps=0.007060508
Epoch 298: f= 379.444, eps=0.007413533
Epoch 299: f= 379.444, eps=0.007784210
Epoch 300: f= 379.444, eps=0.003892105
Epoch 301: f= 379.444, eps=0.001946052
Epoch 302: f= 379.443, eps=0.002043355
Epoch 303: f= 379.443, eps=0.002145523
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Epoch 317: f= 379.443, eps=0.004247988
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Epoch 320: f= 379.443, eps=0.004917578
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Epoch 345: f= 379.443, eps=0.003776114
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Epoch 348: f= 379.443, eps=0.004371324
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Epoch 360: f= 379.443, eps=0.003738224
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Epoch 498: f= 379.443, eps=0.003951982
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 Result after 500 epochs: f=379.44334033241876
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 Epoch 1: f= 1583.127, eps=0.010500000
 Epoch 2: f= 947.857, eps=0.011025000
 Epoch 3: f= 693.550, eps=0.011576250
 Epoch 4: f= 635.926, eps=0.012155063
 Epoch 5: f= 570.957, eps=0.012762816
 Epoch 6: f= 647.160, eps=0.006381408
 Epoch 7: f= 490.047, eps=0.006700478
 Epoch 8: f= 444.285, eps=0.007035502
 Epoch 9: f= 440.912, eps=0.007387277
 Epoch 10: f= 446.954, eps=0.003693639
 Epoch 11: f= 426.953, eps=0.003878321
 Epoch 12: f= 418.657, eps=0.004072237
 Epoch 13: f= 415.928, eps=0.004275848
 Epoch 14: f= 413.540, eps=0.004489641
 Epoch 15: f= 411.871, eps=0.004714123
 Epoch 16: f= 409.908, eps=0.004949829
 Epoch 17: f= 409.495, eps=0.005197320
 Epoch 18: f= 406.112, eps=0.005457186
 Epoch 19: f= 407.358, eps=0.002728593
 Epoch 20: f= 400.862, eps=0.002865023
 Epoch 21: f= 399.721, eps=0.003008274
 Epoch 22: f= 398.804, eps=0.003158688
 Epoch 23: f= 397.930, eps=0.003316622
 Epoch 24: f= 397.103, eps=0.003482453
 Epoch 25: f= 396.314, eps=0.003656576
 Epoch 26: f= 395.586, eps=0.003839405
 Epoch 27: f= 394.929, eps=0.004031375
 Epoch 28: f= 394.433, eps=0.004232944
 Epoch 29: f= 394.112, eps=0.004444591
 Epoch 30: f= 394.219, eps=0.002222295
 Epoch 31: f= 392.382, eps=0.002333410
 Epoch 32: f= 392.096, eps=0.002450081
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 Epoch 34: f= 391.535, eps=0.002701214
 Epoch 35: f= 391.263, eps=0.002836275
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 Epoch 37: f= 390.739, eps=0.003126993
 Epoch 38: f= 390.488, eps=0.003283342
 Epoch 39: f= 390.247, eps=0.003447510
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Epoch 438: f= 386.665, eps=0.004114662
Epoch 439: f= 386.665, eps=0.004320395
Epoch 440: f= 386.665, eps=0.004536415
Epoch 441: f= 386.665, eps=0.004763235
Epoch 442: f= 386.665, eps=0.005001397
Epoch 443: f= 386.665, eps=0.005251467
Epoch 444: f= 386.665, eps=0.005514040
Epoch 445: f= 386.665, eps=0.005789742
Epoch 446: f= 386.665, eps=0.006079230
Epoch 447: f= 386.665, eps=0.006383191
Epoch 448: f= 386.665, eps=0.006702351
Epoch 449: f= 386.665, eps=0.007037468
Epoch 450: f= 386.665, eps=0.007389342
Epoch 451: f= 386.665, eps=0.003694671
Epoch 452: f= 386.665, eps=0.001847335
Epoch 453: f= 386.665, eps=0.001939702
Epoch 454: f= 386.665, eps=0.002036687
Epoch 455: f= 386.665, eps=0.002138522
Epoch 456: f= 386.665, eps=0.002245448
Epoch 457: f= 386.665, eps=0.002357720
Epoch 458: f= 386.665, eps=0.002475606
Epoch 459: f= 386.665, eps=0.002599386
Epoch 460: f= 386.665, eps=0.002729356
Epoch 461: f= 386.665, eps=0.002865824
Epoch 462: f= 386.665, eps=0.003009115
Epoch 463: f= 386.665, eps=0.003159570
Epoch 464: f= 386.665, eps=0.003317549
Epoch 465: f= 386.665, eps=0.003483426
Epoch 466: f= 386.665, eps=0.003657598
Epoch 467: f= 386.665, eps=0.003840478
Epoch 468: f= 386.665, eps=0.004032501
Epoch 469: f= 386.665, eps=0.004234127
Epoch 470: f= 386.665, eps=0.004445833
Epoch 471: f= 386.665, eps=0.004668125
Epoch 472: f= 386.665, eps=0.004901531
Epoch 473: f= 386.665, eps=0.005146607
Epoch 474: f= 386.665, eps=0.005403938
Epoch 475: f= 386.665, eps=0.005674135
Epoch 476: f= 386.665, eps=0.005957841

Epoch 477: f= 386.665, eps=0.006255733
 Epoch 478: f= 386.665, eps=0.006568520
 Epoch 479: f= 386.665, eps=0.006896946
 Epoch 480: f= 386.665, eps=0.003448473
 Epoch 481: f= 386.665, eps=0.001724236
 Epoch 482: f= 386.665, eps=0.001810448
 Epoch 483: f= 386.665, eps=0.001900971
 Epoch 484: f= 386.665, eps=0.001996019
 Epoch 485: f= 386.665, eps=0.002095820
 Epoch 486: f= 386.665, eps=0.002200611
 Epoch 487: f= 386.665, eps=0.002310642
 Epoch 488: f= 386.665, eps=0.002426174
 Epoch 489: f= 386.665, eps=0.002547483
 Epoch 490: f= 386.665, eps=0.002674857
 Epoch 491: f= 386.665, eps=0.002808600
 Epoch 492: f= 386.665, eps=0.002949030
 Epoch 493: f= 386.665, eps=0.003096481
 Epoch 494: f= 386.665, eps=0.003251305
 Epoch 495: f= 386.665, eps=0.003413870
 Epoch 496: f= 386.665, eps=0.003584564
 Epoch 497: f= 386.665, eps=0.003763792
 Epoch 498: f= 386.665, eps=0.003951982
 Epoch 499: f= 386.665, eps=0.004149581
 Result after 500 epochs: f=386.6645111344998
 Epoch 0: f= 3739.131, eps=0.010000000
 Epoch 1: f= 1821.126, eps=0.010500000
 Epoch 2: f= 1030.380, eps=0.011025000
 Epoch 3: f= 735.608, eps=0.011576250
 Epoch 4: f= 669.348, eps=0.012155063
 Epoch 5: f= 617.248, eps=0.012762816
 Epoch 6: f= 849.649, eps=0.006381408
 Epoch 7: f= 526.653, eps=0.006700478
 Epoch 8: f= 458.812, eps=0.007035502
 Epoch 9: f= 448.438, eps=0.007387277
 Epoch 10: f= 461.064, eps=0.003693639
 Epoch 11: f= 433.430, eps=0.003878321
 Epoch 12: f= 427.388, eps=0.004072237
 Epoch 13: f= 425.643, eps=0.004275848
 Epoch 14: f= 424.239, eps=0.004489641
 Epoch 15: f= 423.884, eps=0.004714123
 Epoch 16: f= 422.486, eps=0.004949829
 Epoch 17: f= 423.952, eps=0.002474914
 Epoch 18: f= 419.543, eps=0.002598660
 Epoch 19: f= 418.671, eps=0.002728593
 Epoch 20: f= 418.223, eps=0.002865023
 Epoch 21: f= 417.814, eps=0.003008274
 Epoch 22: f= 417.442, eps=0.003158688
 Epoch 23: f= 417.097, eps=0.003316622

Epoch	24:	f=	416.783,	eps=0.003482453
Epoch	25:	f=	416.496,	eps=0.003656576
Epoch	26:	f=	416.241,	eps=0.003839405
Epoch	27:	f=	416.021,	eps=0.004031375
Epoch	28:	f=	415.867,	eps=0.004232944
Epoch	29:	f=	415.814,	eps=0.004444591
Epoch	30:	f=	416.134,	eps=0.002222295
Epoch	31:	f=	415.292,	eps=0.002333410
Epoch	32:	f=	415.211,	eps=0.002450081
Epoch	33:	f=	415.136,	eps=0.002572585
Epoch	34:	f=	415.063,	eps=0.002701214
Epoch	35:	f=	414.992,	eps=0.002836275
Epoch	36:	f=	414.924,	eps=0.002978088
Epoch	37:	f=	414.858,	eps=0.003126993
Epoch	38:	f=	414.796,	eps=0.003283342
Epoch	39:	f=	414.736,	eps=0.003447510
Epoch	40:	f=	414.678,	eps=0.003619885
Epoch	41:	f=	414.624,	eps=0.003800879
Epoch	42:	f=	414.573,	eps=0.003990923
Epoch	43:	f=	414.525,	eps=0.004190469
Epoch	44:	f=	414.480,	eps=0.004399993
Epoch	45:	f=	414.439,	eps=0.004619993
Epoch	46:	f=	414.402,	eps=0.004850992
Epoch	47:	f=	414.373,	eps=0.005093542
Epoch	48:	f=	414.377,	eps=0.002546771
Epoch	49:	f=	414.328,	eps=0.002674109
Epoch	50:	f=	414.307,	eps=0.002807815
Epoch	51:	f=	414.291,	eps=0.002948206
Epoch	52:	f=	414.276,	eps=0.003095616
Epoch	53:	f=	414.263,	eps=0.003250397
Epoch	54:	f=	414.250,	eps=0.003412917
Epoch	55:	f=	414.238,	eps=0.003583562
Epoch	56:	f=	414.228,	eps=0.003762741
Epoch	57:	f=	414.219,	eps=0.003950878
Epoch	58:	f=	414.215,	eps=0.004148421
Epoch	59:	f=	414.222,	eps=0.002074211
Epoch	60:	f=	414.192,	eps=0.002177921
Epoch	61:	f=	414.185,	eps=0.002286817
Epoch	62:	f=	414.180,	eps=0.002401158
Epoch	63:	f=	414.175,	eps=0.002521216
Epoch	64:	f=	414.171,	eps=0.002647277
Epoch	65:	f=	414.167,	eps=0.002779641
Epoch	66:	f=	414.163,	eps=0.002918623
Epoch	67:	f=	414.159,	eps=0.003064554
Epoch	68:	f=	414.155,	eps=0.003217782
Epoch	69:	f=	414.151,	eps=0.003378671
Epoch	70:	f=	414.148,	eps=0.003547604
Epoch	71:	f=	414.144,	eps=0.003724984

Epoch 72: f= 414.141, eps=0.003911234
 Epoch 73: f= 414.138, eps=0.004106795
 Epoch 74: f= 414.135, eps=0.004312135
 Epoch 75: f= 414.132, eps=0.004527742
 Epoch 76: f= 414.130, eps=0.004754129
 Epoch 77: f= 414.128, eps=0.004991835
 Epoch 78: f= 414.126, eps=0.005241427
 Epoch 79: f= 414.129, eps=0.002620714
 Epoch 80: f= 414.125, eps=0.002751749
 Epoch 81: f= 414.123, eps=0.002889337
 Epoch 82: f= 414.122, eps=0.003033804
 Epoch 83: f= 414.121, eps=0.003185494
 Epoch 84: f= 414.120, eps=0.003344768
 Epoch 85: f= 414.119, eps=0.003512007
 Epoch 86: f= 414.119, eps=0.003687607
 Epoch 87: f= 414.119, eps=0.003871988
 Epoch 88: f= 414.119, eps=0.001935994
 Epoch 89: f= 414.116, eps=0.002032793
 Epoch 90: f= 414.116, eps=0.002134433
 Epoch 91: f= 414.116, eps=0.002241155
 Epoch 92: f= 414.116, eps=0.002353213
 Epoch 93: f= 414.115, eps=0.002470873
 Epoch 94: f= 414.115, eps=0.002594417
 Epoch 95: f= 414.115, eps=0.002724138
 Epoch 96: f= 414.115, eps=0.002860345
 Epoch 97: f= 414.114, eps=0.003003362
 Epoch 98: f= 414.114, eps=0.003153530
 Epoch 99: f= 414.114, eps=0.003311206
 Epoch 100: f= 414.114, eps=0.003476767
 Epoch 101: f= 414.113, eps=0.003650605
 Epoch 102: f= 414.113, eps=0.003833135
 Epoch 103: f= 414.113, eps=0.004024792
 Epoch 104: f= 414.113, eps=0.004226032
 Epoch 105: f= 414.113, eps=0.004437333
 Epoch 106: f= 414.112, eps=0.004659200
 Epoch 107: f= 414.112, eps=0.004892160
 Epoch 108: f= 414.112, eps=0.005136768
 Epoch 109: f= 414.112, eps=0.005393606
 Epoch 110: f= 414.112, eps=0.005663287
 Epoch 111: f= 414.112, eps=0.005946451
 Epoch 112: f= 414.112, eps=0.002973225
 Epoch 113: f= 414.112, eps=0.003121887
 Epoch 114: f= 414.112, eps=0.003277981
 Epoch 115: f= 414.112, eps=0.003441880
 Epoch 116: f= 414.112, eps=0.001720940
 Epoch 117: f= 414.111, eps=0.001806987
 Epoch 118: f= 414.111, eps=0.001897336
 Epoch 119: f= 414.111, eps=0.001992203

Epoch 120: f= 414.111, eps=0.002091813
Epoch 121: f= 414.111, eps=0.002196404
Epoch 122: f= 414.111, eps=0.002306224
Epoch 123: f= 414.111, eps=0.002421535
Epoch 124: f= 414.111, eps=0.002542612
Epoch 125: f= 414.111, eps=0.002669743
Epoch 126: f= 414.111, eps=0.002803230
Epoch 127: f= 414.111, eps=0.002943392
Epoch 128: f= 414.111, eps=0.003090561
Epoch 129: f= 414.111, eps=0.003245089
Epoch 130: f= 414.111, eps=0.003407344
Epoch 131: f= 414.111, eps=0.003577711
Epoch 132: f= 414.111, eps=0.003756596
Epoch 133: f= 414.111, eps=0.003944426
Epoch 134: f= 414.111, eps=0.004141647
Epoch 135: f= 414.111, eps=0.004348730
Epoch 136: f= 414.111, eps=0.004566166
Epoch 137: f= 414.111, eps=0.004794475
Epoch 138: f= 414.111, eps=0.005034198
Epoch 139: f= 414.111, eps=0.005285908
Epoch 140: f= 414.111, eps=0.005550204
Epoch 141: f= 414.111, eps=0.005827714
Epoch 142: f= 414.111, eps=0.006119100
Epoch 143: f= 414.111, eps=0.006425055
Epoch 144: f= 414.111, eps=0.006746307
Epoch 145: f= 414.111, eps=0.007083623
Epoch 146: f= 414.111, eps=0.007437804
Epoch 147: f= 414.111, eps=0.003718902
Epoch 148: f= 414.111, eps=0.001859451
Epoch 149: f= 414.111, eps=0.001952423
Epoch 150: f= 414.111, eps=0.002050045
Epoch 151: f= 414.111, eps=0.002152547
Epoch 152: f= 414.111, eps=0.002260174
Epoch 153: f= 414.111, eps=0.002373183
Epoch 154: f= 414.111, eps=0.002491842
Epoch 155: f= 414.111, eps=0.002616434
Epoch 156: f= 414.111, eps=0.002747256
Epoch 157: f= 414.111, eps=0.002884619
Epoch 158: f= 414.111, eps=0.003028850
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Epoch 166: f= 414.111, eps=0.004474990
Epoch 167: f= 414.111, eps=0.004698740

Epoch 168: f= 414.111, eps=0.004933677
Epoch 169: f= 414.111, eps=0.005180361
Epoch 170: f= 414.111, eps=0.005439379
Epoch 171: f= 414.111, eps=0.005711348
Epoch 172: f= 414.111, eps=0.005996915
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Epoch 174: f= 414.111, eps=0.003148380
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Epoch 192: f= 414.111, eps=0.003608073
Epoch 193: f= 414.111, eps=0.003788476
Epoch 194: f= 414.111, eps=0.003977900
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Epoch 196: f= 414.111, eps=0.004385635
Epoch 197: f= 414.111, eps=0.004604917
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Epoch 200: f= 414.111, eps=0.005330767
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Epoch 203: f= 414.111, eps=0.006171029
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Epoch 256: f= 414.111, eps=0.004212241
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Epoch 264: f= 414.111, eps=0.006223399
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Epoch 275: f= 414.111, eps=0.002413634
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Epoch 277: f= 414.111, eps=0.002661031
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Epoch 282: f= 414.111, eps=0.003396225
Epoch 283: f= 414.111, eps=0.003566036
Epoch 284: f= 414.111, eps=0.003744338
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Epoch 286: f= 414.111, eps=0.004128133
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Epoch 309: f= 414.111, eps=0.002875206
Epoch 310: f= 414.111, eps=0.003018966
Epoch 311: f= 414.111, eps=0.003169914

Epoch 312: f= 414.111, eps=0.003328410
Epoch 313: f= 414.111, eps=0.003494831
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Epoch 317: f= 414.111, eps=0.004247988
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Epoch 319: f= 414.111, eps=0.004683407
Epoch 320: f= 414.111, eps=0.004917578
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Epoch 325: f= 414.111, eps=0.006276214
Epoch 326: f= 414.111, eps=0.006590024
Epoch 327: f= 414.111, eps=0.006919525
Epoch 328: f= 414.111, eps=0.0073459763
Epoch 329: f= 414.111, eps=0.007729881
Epoch 330: f= 414.111, eps=0.00816375
Epoch 331: f= 414.111, eps=0.008607194
Epoch 332: f= 414.111, eps=0.009060254
Epoch 333: f= 414.111, eps=0.0095210682
Epoch 334: f= 414.111, eps=0.0099907816
Epoch 335: f= 414.111, eps=0.010468206
Epoch 336: f= 414.111, eps=0.0109534117
Epoch 337: f= 414.111, eps=0.0114455823
Epoch 338: f= 414.111, eps=0.0119443614
Epoch 339: f= 414.111, eps=0.0124497794
Epoch 340: f= 414.111, eps=0.0129618684
Epoch 341: f= 414.111, eps=0.0134796618
Epoch 342: f= 414.111, eps=0.0139931949
Epoch 343: f= 414.111, eps=0.0145125047
Epoch 344: f= 414.111, eps=0.0150376299
Epoch 345: f= 414.111, eps=0.0155685114
Epoch 346: f= 414.111, eps=0.0160951920
Epoch 347: f= 414.111, eps=0.0166276166
Epoch 348: f= 414.111, eps=0.0171658324
Epoch 349: f= 414.111, eps=0.0177098890
Epoch 350: f= 414.111, eps=0.0182597385
Epoch 351: f= 414.111, eps=0.0188154354
Epoch 352: f= 414.111, eps=0.0193769372
Epoch 353: f= 414.111, eps=0.0199442940
Epoch 354: f= 414.111, eps=0.0205175992
Epoch 355: f= 414.111, eps=0.0210968892
Epoch 356: f= 414.111, eps=0.0216821437
Epoch 357: f= 414.111, eps=0.022273358
Epoch 358: f= 414.111, eps=0.022869526
Epoch 359: f= 414.111, eps=0.0234716213

Epoch 360: f= 414.111, eps=0.003738224
Epoch 361: f= 414.111, eps=0.001869112
Epoch 362: f= 414.111, eps=0.001962567
Epoch 363: f= 414.111, eps=0.002060696
Epoch 364: f= 414.111, eps=0.002163731
Epoch 365: f= 414.111, eps=0.002271917
Epoch 366: f= 414.111, eps=0.002385513
Epoch 367: f= 414.111, eps=0.002504789
Epoch 368: f= 414.111, eps=0.002630028
Epoch 369: f= 414.111, eps=0.002761530
Epoch 370: f= 414.111, eps=0.002899606
Epoch 371: f= 414.111, eps=0.003044586
Epoch 372: f= 414.111, eps=0.003196816
Epoch 373: f= 414.111, eps=0.003356656
Epoch 374: f= 414.111, eps=0.003524489
Epoch 375: f= 414.111, eps=0.003700714
Epoch 376: f= 414.111, eps=0.003885749
Epoch 377: f= 414.111, eps=0.004080037
Epoch 378: f= 414.111, eps=0.004284039
Epoch 379: f= 414.111, eps=0.002142019
Epoch 380: f= 414.111, eps=0.002249120
Epoch 381: f= 414.111, eps=0.002361576
Epoch 382: f= 414.111, eps=0.002479655
Epoch 383: f= 414.111, eps=0.001239828
Epoch 384: f= 414.111, eps=0.001301819
Epoch 385: f= 414.111, eps=0.001366910
Epoch 386: f= 414.111, eps=0.001435255
Epoch 387: f= 414.111, eps=0.001507018
Epoch 388: f= 414.111, eps=0.001582369
Epoch 389: f= 414.111, eps=0.000791185
Epoch 390: f= 414.111, eps=0.000395592
Epoch 391: f= 414.111, eps=0.000415372
Epoch 392: f= 414.111, eps=0.000436140
Epoch 393: f= 414.111, eps=0.000457947
Epoch 394: f= 414.111, eps=0.000228974
Epoch 395: f= 414.111, eps=0.000240422
Epoch 396: f= 414.111, eps=0.000252444
Epoch 397: f= 414.111, eps=0.000265066
Epoch 398: f= 414.111, eps=0.000278319
Epoch 399: f= 414.111, eps=0.000292235
Epoch 400: f= 414.111, eps=0.000146117
Epoch 401: f= 414.111, eps=0.000153423
Epoch 402: f= 414.111, eps=0.000161095
Epoch 403: f= 414.111, eps=0.000080547
Epoch 404: f= 414.111, eps=0.000084575
Epoch 405: f= 414.111, eps=0.000042287
Epoch 406: f= 414.111, eps=0.000044402
Epoch 407: f= 414.111, eps=0.000046622

Epoch 408: f= 414.111, eps=0.000048953
Epoch 409: f= 414.111, eps=0.000051400
Epoch 410: f= 414.111, eps=0.000053971
Epoch 411: f= 414.111, eps=0.000056669
Epoch 412: f= 414.111, eps=0.000059502
Epoch 413: f= 414.111, eps=0.000029751
Epoch 414: f= 414.111, eps=0.000031239
Epoch 415: f= 414.111, eps=0.000032801
Epoch 416: f= 414.111, eps=0.000034441
Epoch 417: f= 414.111, eps=0.000017220
Epoch 418: f= 414.111, eps=0.000008610
Epoch 419: f= 414.111, eps=0.000009041
Epoch 420: f= 414.111, eps=0.000009493
Epoch 421: f= 414.111, eps=0.000009967
Epoch 422: f= 414.111, eps=0.000010466
Epoch 423: f= 414.111, eps=0.000005233
Epoch 424: f= 414.111, eps=0.000005495
Epoch 425: f= 414.111, eps=0.000005769
Epoch 426: f= 414.111, eps=0.000006058
Epoch 427: f= 414.111, eps=0.000006361
Epoch 428: f= 414.111, eps=0.000006679
Epoch 429: f= 414.111, eps=0.000007013
Epoch 430: f= 414.111, eps=0.000003506
Epoch 431: f= 414.111, eps=0.000003682
Epoch 432: f= 414.111, eps=0.000003866
Epoch 433: f= 414.111, eps=0.000001933
Epoch 434: f= 414.111, eps=0.000002029
Epoch 435: f= 414.111, eps=0.000002131
Epoch 436: f= 414.111, eps=0.000002237
Epoch 437: f= 414.111, eps=0.000002349
Epoch 438: f= 414.111, eps=0.000002467
Epoch 439: f= 414.111, eps=0.000001233
Epoch 440: f= 414.111, eps=0.000001295
Epoch 441: f= 414.111, eps=0.000001360
Epoch 442: f= 414.111, eps=0.000001428
Epoch 443: f= 414.111, eps=0.000001499
Epoch 444: f= 414.111, eps=0.000000750
Epoch 445: f= 414.111, eps=0.000000787
Epoch 446: f= 414.111, eps=0.000000826
Epoch 447: f= 414.111, eps=0.000000868
Epoch 448: f= 414.111, eps=0.000000911
Epoch 449: f= 414.111, eps=0.000000456
Epoch 450: f= 414.111, eps=0.000000478
Epoch 451: f= 414.111, eps=0.000000502
Epoch 452: f= 414.111, eps=0.000000527
Epoch 453: f= 414.111, eps=0.000000554
Epoch 454: f= 414.111, eps=0.000000581
Epoch 455: f= 414.111, eps=0.000000611

Epoch 456: f= 414.111, eps=0.000000305
 Epoch 457: f= 414.111, eps=0.000000321
 Epoch 458: f= 414.111, eps=0.000000337
 Epoch 459: f= 414.111, eps=0.000000353
 Epoch 460: f= 414.111, eps=0.000000371
 Epoch 461: f= 414.111, eps=0.000000390
 Epoch 462: f= 414.111, eps=0.000000195
 Epoch 463: f= 414.111, eps=0.000000097
 Epoch 464: f= 414.111, eps=0.000000102
 Epoch 465: f= 414.111, eps=0.000000107
 Epoch 466: f= 414.111, eps=0.000000113
 Epoch 467: f= 414.111, eps=0.000000118
 Epoch 468: f= 414.111, eps=0.000000124
 Epoch 469: f= 414.111, eps=0.000000062
 Epoch 470: f= 414.111, eps=0.000000031
 Epoch 471: f= 414.111, eps=0.000000033
 Epoch 472: f= 414.111, eps=0.000000034
 Epoch 473: f= 414.111, eps=0.000000036
 Epoch 474: f= 414.111, eps=0.000000038
 Epoch 475: f= 414.111, eps=0.000000019
 Epoch 476: f= 414.111, eps=0.000000020
 Epoch 477: f= 414.111, eps=0.000000021
 Epoch 478: f= 414.111, eps=0.000000010
 Epoch 479: f= 414.111, eps=0.000000011
 Epoch 480: f= 414.111, eps=0.000000011
 Epoch 481: f= 414.111, eps=0.000000012
 Epoch 482: f= 414.111, eps=0.000000013
 Epoch 483: f= 414.111, eps=0.000000006
 Epoch 484: f= 414.111, eps=0.000000007
 Epoch 485: f= 414.111, eps=0.000000007
 Epoch 486: f= 414.111, eps=0.000000007
 Epoch 487: f= 414.111, eps=0.000000008
 Epoch 488: f= 414.111, eps=0.000000008
 Epoch 489: f= 414.111, eps=0.000000008
 Epoch 490: f= 414.111, eps=0.000000009
 Epoch 491: f= 414.111, eps=0.000000009
 Epoch 492: f= 414.111, eps=0.000000010
 Epoch 493: f= 414.111, eps=0.000000010
 Epoch 494: f= 414.111, eps=0.000000011
 Epoch 495: f= 414.111, eps=0.000000011
 Epoch 496: f= 414.111, eps=0.000000012
 Epoch 497: f= 414.111, eps=0.000000013
 Epoch 498: f= 414.111, eps=0.000000013
 Epoch 499: f= 414.111, eps=0.000000014
 Result after 500 epochs: f=414.1111711137437
 Epoch 0: f= 4074.746, eps=0.010000000
 Epoch 1: f= 2265.591, eps=0.010500000
 Epoch 2: f= 1082.377, eps=0.011025000

Epoch	3:	f=	716.768,	eps=0.011576250
Epoch	4:	f=	681.485,	eps=0.012155063
Epoch	5:	f=	725.750,	eps=0.006077531
Epoch	6:	f=	725.786,	eps=0.003038766
Epoch	7:	f=	550.766,	eps=0.003190704
Epoch	8:	f=	487.585,	eps=0.003350239
Epoch	9:	f=	468.709,	eps=0.003517751
Epoch	10:	f=	460.748,	eps=0.003693639
Epoch	11:	f=	457.667,	eps=0.003878321
Epoch	12:	f=	455.630,	eps=0.004072237
Epoch	13:	f=	454.261,	eps=0.004275848
Epoch	14:	f=	453.340,	eps=0.004489641
Epoch	15:	f=	452.926,	eps=0.004714123
Epoch	16:	f=	452.779,	eps=0.004949829
Epoch	17:	f=	454.323,	eps=0.002474914
Epoch	18:	f=	451.622,	eps=0.002598660
Epoch	19:	f=	451.259,	eps=0.002728593
Epoch	20:	f=	451.131,	eps=0.002865023
Epoch	21:	f=	451.024,	eps=0.003008274
Epoch	22:	f=	450.933,	eps=0.003158688
Epoch	23:	f=	450.855,	eps=0.003316622
Epoch	24:	f=	450.787,	eps=0.003482453
Epoch	25:	f=	450.730,	eps=0.003656576
Epoch	26:	f=	450.682,	eps=0.003839405
Epoch	27:	f=	450.643,	eps=0.004031375
Epoch	28:	f=	450.613,	eps=0.004232944
Epoch	29:	f=	450.594,	eps=0.004444591
Epoch	30:	f=	450.601,	eps=0.002222295
Epoch	31:	f=	450.549,	eps=0.002333410
Epoch	32:	f=	450.538,	eps=0.002450081
Epoch	33:	f=	450.530,	eps=0.002572585
Epoch	34:	f=	450.524,	eps=0.002701214
Epoch	35:	f=	450.517,	eps=0.002836275
Epoch	36:	f=	450.512,	eps=0.002978088
Epoch	37:	f=	450.507,	eps=0.003126993
Epoch	38:	f=	450.503,	eps=0.003283342
Epoch	39:	f=	450.499,	eps=0.003447510
Epoch	40:	f=	450.495,	eps=0.003619885
Epoch	41:	f=	450.493,	eps=0.003800879
Epoch	42:	f=	450.490,	eps=0.003990923
Epoch	43:	f=	450.488,	eps=0.004190469
Epoch	44:	f=	450.486,	eps=0.004399993
Epoch	45:	f=	450.485,	eps=0.004619993
Epoch	46:	f=	450.484,	eps=0.004850992
Epoch	47:	f=	450.483,	eps=0.005093542
Epoch	48:	f=	450.483,	eps=0.002546771
Epoch	49:	f=	450.482,	eps=0.002674109
Epoch	50:	f=	450.481,	eps=0.002807815

Epoch	51:	f=	450.481,	eps=0.002948206
Epoch	52:	f=	450.481,	eps=0.003095616
Epoch	53:	f=	450.481,	eps=0.003250397
Epoch	54:	f=	450.480,	eps=0.003412917
Epoch	55:	f=	450.480,	eps=0.003583562
Epoch	56:	f=	450.480,	eps=0.003762741
Epoch	57:	f=	450.480,	eps=0.003950878
Epoch	58:	f=	450.480,	eps=0.004148421
Epoch	59:	f=	450.480,	eps=0.004355843
Epoch	60:	f=	450.480,	eps=0.002177921
Epoch	61:	f=	450.480,	eps=0.002286817
Epoch	62:	f=	450.480,	eps=0.002401158
Epoch	63:	f=	450.479,	eps=0.002521216
Epoch	64:	f=	450.479,	eps=0.002647277
Epoch	65:	f=	450.479,	eps=0.002779641
Epoch	66:	f=	450.479,	eps=0.002918623
Epoch	67:	f=	450.479,	eps=0.003064554
Epoch	68:	f=	450.479,	eps=0.003217782
Epoch	69:	f=	450.479,	eps=0.003378671
Epoch	70:	f=	450.479,	eps=0.003547604
Epoch	71:	f=	450.479,	eps=0.003724984
Epoch	72:	f=	450.479,	eps=0.003911234
Epoch	73:	f=	450.479,	eps=0.004106795
Epoch	74:	f=	450.479,	eps=0.004312135
Epoch	75:	f=	450.479,	eps=0.004527742
Epoch	76:	f=	450.479,	eps=0.004754129
Epoch	77:	f=	450.479,	eps=0.004991835
Epoch	78:	f=	450.479,	eps=0.005241427
Epoch	79:	f=	450.479,	eps=0.002620714
Epoch	80:	f=	450.479,	eps=0.002751749
Epoch	81:	f=	450.479,	eps=0.002889337
Epoch	82:	f=	450.479,	eps=0.003033804
Epoch	83:	f=	450.479,	eps=0.003185494
Epoch	84:	f=	450.479,	eps=0.003344768
Epoch	85:	f=	450.479,	eps=0.003512007
Epoch	86:	f=	450.479,	eps=0.003687607
Epoch	87:	f=	450.479,	eps=0.003871988
Epoch	88:	f=	450.479,	eps=0.004065587
Epoch	89:	f=	450.479,	eps=0.004268866
Epoch	90:	f=	450.479,	eps=0.002134433
Epoch	91:	f=	450.479,	eps=0.002241155
Epoch	92:	f=	450.479,	eps=0.002353213
Epoch	93:	f=	450.479,	eps=0.002470873
Epoch	94:	f=	450.479,	eps=0.002594417
Epoch	95:	f=	450.479,	eps=0.002724138
Epoch	96:	f=	450.479,	eps=0.002860345
Epoch	97:	f=	450.479,	eps=0.003003362
Epoch	98:	f=	450.479,	eps=0.003153530

Epoch 99: f= 450.479, eps=0.003311206
Epoch 100: f= 450.479, eps=0.003476767
Epoch 101: f= 450.479, eps=0.003650605
Epoch 102: f= 450.479, eps=0.003833135
Epoch 103: f= 450.479, eps=0.004024792
Epoch 104: f= 450.479, eps=0.004226032
Epoch 105: f= 450.479, eps=0.004437333
Epoch 106: f= 450.479, eps=0.004659200
Epoch 107: f= 450.479, eps=0.004892160
Epoch 108: f= 450.479, eps=0.005136768
Epoch 109: f= 450.479, eps=0.005393606
Epoch 110: f= 450.479, eps=0.002696803
Epoch 111: f= 450.479, eps=0.002831643
Epoch 112: f= 450.479, eps=0.002973225
Epoch 113: f= 450.479, eps=0.003121887
Epoch 114: f= 450.479, eps=0.003277981
Epoch 115: f= 450.479, eps=0.003441880
Epoch 116: f= 450.479, eps=0.003613974
Epoch 117: f= 450.479, eps=0.003794673
Epoch 118: f= 450.479, eps=0.003984406
Epoch 119: f= 450.479, eps=0.004183627
Epoch 120: f= 450.479, eps=0.002091813
Epoch 121: f= 450.479, eps=0.002196404
Epoch 122: f= 450.479, eps=0.002306224
Epoch 123: f= 450.479, eps=0.002421535
Epoch 124: f= 450.479, eps=0.002542612
Epoch 125: f= 450.479, eps=0.002669743
Epoch 126: f= 450.479, eps=0.002803230
Epoch 127: f= 450.479, eps=0.002943392
Epoch 128: f= 450.479, eps=0.003090561
Epoch 129: f= 450.479, eps=0.003245089
Epoch 130: f= 450.479, eps=0.003407344
Epoch 131: f= 450.479, eps=0.003577711
Epoch 132: f= 450.479, eps=0.003756596
Epoch 133: f= 450.479, eps=0.003944426
Epoch 134: f= 450.479, eps=0.004141647
Epoch 135: f= 450.479, eps=0.004348730
Epoch 136: f= 450.479, eps=0.004566166
Epoch 137: f= 450.479, eps=0.004794475
Epoch 138: f= 450.479, eps=0.005034198
Epoch 139: f= 450.479, eps=0.005285908
Epoch 140: f= 450.479, eps=0.005550204
Epoch 141: f= 450.479, eps=0.002775102
Epoch 142: f= 450.479, eps=0.002913857
Epoch 143: f= 450.479, eps=0.003059550
Epoch 144: f= 450.479, eps=0.003212527
Epoch 145: f= 450.479, eps=0.003373154
Epoch 146: f= 450.479, eps=0.003541811

Epoch 147: f= 450.479, eps=0.003718902
Epoch 148: f= 450.479, eps=0.003904847
Epoch 149: f= 450.479, eps=0.001952423
Epoch 150: f= 450.479, eps=0.002050045
Epoch 151: f= 450.479, eps=0.002152547
Epoch 152: f= 450.479, eps=0.002260174
Epoch 153: f= 450.479, eps=0.002373183
Epoch 154: f= 450.479, eps=0.002491842
Epoch 155: f= 450.479, eps=0.002616434
Epoch 156: f= 450.479, eps=0.002747256
Epoch 157: f= 450.479, eps=0.002884619
Epoch 158: f= 450.479, eps=0.003028850
Epoch 159: f= 450.479, eps=0.003180292
Epoch 160: f= 450.479, eps=0.003339307
Epoch 161: f= 450.479, eps=0.003506272
Epoch 162: f= 450.479, eps=0.003681586
Epoch 163: f= 450.479, eps=0.003865665
Epoch 164: f= 450.479, eps=0.004058948
Epoch 165: f= 450.479, eps=0.004261896
Epoch 166: f= 450.479, eps=0.004474990
Epoch 167: f= 450.479, eps=0.004698740
Epoch 168: f= 450.479, eps=0.004933677
Epoch 169: f= 450.479, eps=0.005180361
Epoch 170: f= 450.479, eps=0.005439379
Epoch 171: f= 450.479, eps=0.005711348
Epoch 172: f= 450.479, eps=0.005996915
Epoch 173: f= 450.479, eps=0.006296761
Epoch 174: f= 450.479, eps=0.003148380
Epoch 175: f= 450.479, eps=0.003305799
Epoch 176: f= 450.479, eps=0.003471089
Epoch 177: f= 450.479, eps=0.003644644
Epoch 178: f= 450.479, eps=0.001822322
Epoch 179: f= 450.479, eps=0.001913438
Epoch 180: f= 450.479, eps=0.002009110
Epoch 181: f= 450.479, eps=0.002109565
Epoch 182: f= 450.479, eps=0.002215044
Epoch 183: f= 450.479, eps=0.002325796
Epoch 184: f= 450.479, eps=0.002442086
Epoch 185: f= 450.479, eps=0.002564190
Epoch 186: f= 450.479, eps=0.002692399
Epoch 187: f= 450.479, eps=0.002827019
Epoch 188: f= 450.479, eps=0.002968370
Epoch 189: f= 450.479, eps=0.003116789
Epoch 190: f= 450.479, eps=0.003272628
Epoch 191: f= 450.479, eps=0.003436260
Epoch 192: f= 450.479, eps=0.003608073
Epoch 193: f= 450.479, eps=0.003788476
Epoch 194: f= 450.479, eps=0.003977900

Epoch 195: f= 450.479, eps=0.004176795
Epoch 196: f= 450.479, eps=0.004385635
Epoch 197: f= 450.479, eps=0.004604917
Epoch 198: f= 450.479, eps=0.004835163
Epoch 199: f= 450.479, eps=0.005076921
Epoch 200: f= 450.479, eps=0.005330767
Epoch 201: f= 450.479, eps=0.005597305
Epoch 202: f= 450.479, eps=0.005877170
Epoch 203: f= 450.479, eps=0.006171029
Epoch 204: f= 450.479, eps=0.006479580
Epoch 205: f= 450.479, eps=0.003239790
Epoch 206: f= 450.479, eps=0.003401780
Epoch 207: f= 450.479, eps=0.003571869
Epoch 208: f= 450.479, eps=0.003750462
Epoch 209: f= 450.479, eps=0.001875231
Epoch 210: f= 450.479, eps=0.001968993
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Epoch 220: f= 450.479, eps=0.000346321
Epoch 221: f= 450.479, eps=0.000363637
Epoch 222: f= 450.479, eps=0.000181819
Epoch 223: f= 450.479, eps=0.000190910
Epoch 224: f= 450.479, eps=0.000200455
Epoch 225: f= 450.479, eps=0.000100228
Epoch 226: f= 450.479, eps=0.000105239
Epoch 227: f= 450.479, eps=0.000110501
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Epoch 481: f= 450.479, eps=0.000000000
Epoch 482: f= 450.479, eps=0.000000000


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Epoch 483: f= 450.479, eps=0.000000000
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Epoch 485: f= 450.479, eps=0.000000000
Epoch 486: f= 450.479, eps=0.000000000
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Epoch 497: f= 450.479, eps=0.000000000
Epoch 498: f= 450.479, eps=0.000000000
Epoch 499: f= 450.479, eps=0.000000000
Result after 500 epochs: f=450.4792408532154
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Epoch 1: f= 6725.770, eps=0.010500000
Epoch 2: f= 5125.642, eps=0.011025000
Epoch 3: f= 28027.453, eps=0.005512500
Epoch 4: f= 5292.550, eps=0.005788125
Epoch 5: f= 965.989, eps=0.006077531
Epoch 6: f= 685.912, eps=0.006381408
Epoch 7: f= 999.714, eps=0.003190704
Epoch 8: f= 628.348, eps=0.003350239
Epoch 9: f= 579.496, eps=0.003517751
Epoch 10: f= 578.458, eps=0.003693639
Epoch 11: f= 579.127, eps=0.001846819
Epoch 12: f= 576.088, eps=0.001939160
Epoch 13: f= 575.942, eps=0.002036118
Epoch 14: f= 575.935, eps=0.002137924
Epoch 15: f= 575.934, eps=0.002244820
Epoch 16: f= 575.934, eps=0.002357061
Epoch 17: f= 575.934, eps=0.002474914
Epoch 18: f= 575.933, eps=0.002598660
Epoch 19: f= 575.933, eps=0.002728593
Epoch 20: f= 575.933, eps=0.002865023
Epoch 21: f= 575.933, eps=0.003008274
Epoch 22: f= 575.933, eps=0.003158688
Epoch 23: f= 575.933, eps=0.003316622
Epoch 24: f= 575.933, eps=0.003482453
Epoch 25: f= 575.933, eps=0.003656576
Epoch 26: f= 575.933, eps=0.001828288
Epoch 27: f= 575.933, eps=0.001919702
Epoch 28: f= 575.933, eps=0.002015687
Epoch 29: f= 575.933, eps=0.002116472

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Epoch 30: f= 575.933, eps=0.002222295
Epoch 31: f= 575.933, eps=0.002333410
Epoch 32: f= 575.933, eps=0.002450081
Epoch 33: f= 575.933, eps=0.002572585
Epoch 34: f= 575.933, eps=0.002701214
Epoch 35: f= 575.933, eps=0.002836275
Epoch 36: f= 575.933, eps=0.002978088
Epoch 37: f= 575.933, eps=0.003126993
Epoch 38: f= 575.933, eps=0.003283342
Epoch 39: f= 575.933, eps=0.003447510
Epoch 40: f= 575.933, eps=0.003619885
Epoch 41: f= 575.933, eps=0.003800879
Epoch 42: f= 575.933, eps=0.003990923
Epoch 43: f= 575.933, eps=0.004190469
Epoch 44: f= 575.933, eps=0.004399993
Epoch 45: f= 575.933, eps=0.002199996
Epoch 46: f= 575.933, eps=0.002309996
Epoch 47: f= 575.933, eps=0.002425496
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Epoch 78: f= 575.933, eps=0.001188532
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Epoch 86: f= 575.933, eps=0.000836192
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Epoch 89: f= 575.933, eps=0.000967997
Epoch 90: f= 575.933, eps=0.001016397
Epoch 91: f= 575.933, eps=0.001067217
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Epoch 93: f= 575.933, eps=0.001176606
Epoch 94: f= 575.933, eps=0.000588303
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Epoch 97: f= 575.933, eps=0.000681034
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Epoch 123: f= 575.933, eps=0.002421535
Epoch 124: f= 575.933, eps=0.002542612
Epoch 125: f= 575.933, eps=0.002669743

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Epoch 134: f= 575.933, eps=0.001972213
Epoch 135: f= 575.933, eps=0.002070824
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Epoch 138: f= 575.933, eps=0.002397237
Epoch 139: f= 575.933, eps=0.002517099
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Epoch 146: f= 575.933, eps=0.003541811
Epoch 147: f= 575.933, eps=0.003718902
Epoch 148: f= 575.933, eps=0.003904847
Epoch 149: f= 575.933, eps=0.004100089
Epoch 150: f= 575.933, eps=0.004305094
Epoch 151: f= 575.933, eps=0.004520348
Epoch 152: f= 575.933, eps=0.002260174
Epoch 153: f= 575.933, eps=0.002373183
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Epoch 462: f= 575.933, eps=0.000682339
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Epoch 467: f= 575.933, eps=0.000870857
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Epoch 480: f= 575.933, eps=0.000781967
Epoch 481: f= 575.933, eps=0.000821065
Epoch 482: f= 575.933, eps=0.000862118
Epoch 483: f= 575.933, eps=0.000905224
Epoch 484: f= 575.933, eps=0.000950485
Epoch 485: f= 575.933, eps=0.000998010
Epoch 486: f= 575.933, eps=0.000499005
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Epoch 489: f= 575.933, eps=0.000577660
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Epoch 491: f= 575.933, eps=0.000636871
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Epoch 494: f= 575.933, eps=0.000737257
Epoch 495: f= 575.933, eps=0.000774120
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Epoch 498: f= 575.933, eps=0.000896141
Epoch 499: f= 575.933, eps=0.000940948
Result after 500 epochs: f=575.9333931856461
Epoch 0: f= 10115.815, eps=0.010000000
Epoch 1: f= 26233.982, eps=0.005000000
Epoch 2: f= 1807.440, eps=0.005250000
Epoch 3: f= 4190.824, eps=0.002625000
Epoch 4: f= 1056.775, eps=0.002756250
Epoch 5: f= 666.044, eps=0.002894063
Epoch 6: f= 657.393, eps=0.003038766
Epoch 7: f= 660.438, eps=0.001519383
Epoch 8: f= 648.568, eps=0.001595352

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Epoch	10:	f=	647.116,	eps=0.001758876
Epoch	11:	f=	647.109,	eps=0.001846819
Epoch	12:	f=	647.108,	eps=0.001939160
Epoch	13:	f=	647.107,	eps=0.002036118
Epoch	14:	f=	647.107,	eps=0.002137924
Epoch	15:	f=	647.107,	eps=0.002244820
Epoch	16:	f=	647.107,	eps=0.002357061
Epoch	17:	f=	647.107,	eps=0.002474914
Epoch	18:	f=	647.107,	eps=0.002598660
Epoch	19:	f=	647.107,	eps=0.001299330
Epoch	20:	f=	647.107,	eps=0.001364297
Epoch	21:	f=	647.107,	eps=0.001432511
Epoch	22:	f=	647.107,	eps=0.001504137
Epoch	23:	f=	647.107,	eps=0.001579344
Epoch	24:	f=	647.107,	eps=0.001658311
Epoch	25:	f=	647.107,	eps=0.001741227
Epoch	26:	f=	647.107,	eps=0.001828288
Epoch	27:	f=	647.107,	eps=0.001919702
Epoch	28:	f=	647.107,	eps=0.002015687
Epoch	29:	f=	647.107,	eps=0.002116472
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Epoch	33:	f=	647.107,	eps=0.001225040
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Epoch	35:	f=	647.107,	eps=0.001350607
Epoch	36:	f=	647.107,	eps=0.001418137
Epoch	37:	f=	647.107,	eps=0.001489044
Epoch	38:	f=	647.107,	eps=0.001563496
Epoch	39:	f=	647.107,	eps=0.001641671
Epoch	40:	f=	647.107,	eps=0.000820836
Epoch	41:	f=	647.107,	eps=0.000861877
Epoch	42:	f=	647.107,	eps=0.000904971
Epoch	43:	f=	647.107,	eps=0.000950220
Epoch	44:	f=	647.107,	eps=0.000997731
Epoch	45:	f=	647.107,	eps=0.001047617
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Epoch	47:	f=	647.107,	eps=0.001154998
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Epoch	49:	f=	647.107,	eps=0.001273385
Epoch	50:	f=	647.107,	eps=0.001337055
Epoch	51:	f=	647.107,	eps=0.001403907
Epoch	52:	f=	647.107,	eps=0.001474103
Epoch	53:	f=	647.107,	eps=0.001547808
Epoch	54:	f=	647.107,	eps=0.001625198
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Epoch 397: f= 647.107, eps=0.002454774
Epoch 398: f= 647.107, eps=0.002577512
Epoch 399: f= 647.107, eps=0.002706388
Epoch 400: f= 647.107, eps=0.002841708
Epoch 401: f= 647.107, eps=0.002983793
Epoch 402: f= 647.107, eps=0.003132983
Epoch 403: f= 647.107, eps=0.003289632
Epoch 404: f= 647.107, eps=0.003454113
Epoch 405: f= 647.107, eps=0.003626819
Epoch 406: f= 647.107, eps=0.003808160
Epoch 407: f= 647.107, eps=0.003998568
Epoch 408: f= 647.107, eps=0.004198496
Epoch 409: f= 647.107, eps=0.004408421
Epoch 410: f= 647.107, eps=0.004628842
Epoch 411: f= 647.107, eps=0.004860284
Epoch 412: f= 647.107, eps=0.005103298
Epoch 413: f= 647.107, eps=0.005358463
Epoch 414: f= 647.107, eps=0.005626387
Epoch 415: f= 647.107, eps=0.005907706
Epoch 416: f= 647.107, eps=0.006203091
Epoch 417: f= 647.107, eps=0.006513246
Epoch 418: f= 647.107, eps=0.006838908
Epoch 419: f= 647.107, eps=0.007181954
Epoch 420: f= 647.107, eps=0.007542427
Epoch 421: f= 647.107, eps=0.007920498
Epoch 422: f= 647.107, eps=0.008316274
Epoch 423: f= 647.107, eps=0.008730855
Epoch 424: f= 647.107, eps=0.009165341
Epoch 425: f= 647.107, eps=0.009620842
Epoch 426: f= 647.107, eps=0.010098468
Epoch 427: f= 647.107, eps=0.010599329
Epoch 428: f= 647.107, eps=0.011124635
Epoch 429: f= 647.107, eps=0.011675586
Epoch 430: f= 647.107, eps=0.012253391
Epoch 431: f= 647.107, eps=0.012858301
Epoch 432: f= 647.107, eps=0.013491626
Epoch 433: f= 647.107, eps=0.014154775
Epoch 434: f= 647.107, eps=0.014848148
Epoch 435: f= 647.107, eps=0.015573154
Epoch 436: f= 647.107, eps=0.016331203
Epoch 437: f= 647.107, eps=0.017123804
Epoch 438: f= 647.107, eps=0.017952457
Epoch 439: f= 647.107, eps=0.018818671
Epoch 440: f= 647.107, eps=0.019724046

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Epoch 442: f= 647.107, eps=0.000540049
Epoch 443: f= 647.107, eps=0.000567052
Epoch 444: f= 647.107, eps=0.000595404
Epoch 445: f= 647.107, eps=0.000625175
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Epoch 447: f= 647.107, eps=0.000689255
Epoch 448: f= 647.107, eps=0.000723718
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Epoch 450: f= 647.107, eps=0.000797899
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Epoch 452: f= 647.107, eps=0.000879684
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Epoch 454: f= 647.107, eps=0.000969851
Epoch 455: f= 647.107, eps=0.001018344
Epoch 456: f= 647.107, eps=0.001069261
Epoch 457: f= 647.107, eps=0.001122724
Epoch 458: f= 647.107, eps=0.001178860
Epoch 459: f= 647.107, eps=0.001237803
Epoch 460: f= 647.107, eps=0.001299693
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Epoch 462: f= 647.107, eps=0.001432912
Epoch 463: f= 647.107, eps=0.001504557
Epoch 464: f= 647.107, eps=0.001579785
Epoch 465: f= 647.107, eps=0.001658774
Epoch 466: f= 647.107, eps=0.001741713
Epoch 467: f= 647.107, eps=0.001828799
Epoch 468: f= 647.107, eps=0.001920239
Epoch 469: f= 647.107, eps=0.002016251
Epoch 470: f= 647.107, eps=0.002117063
Epoch 471: f= 647.107, eps=0.002222916
Epoch 472: f= 647.107, eps=0.002334062
Epoch 473: f= 647.107, eps=0.002450765
Epoch 474: f= 647.107, eps=0.002573304
Epoch 475: f= 647.107, eps=0.002701969
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Epoch 478: f= 647.107, eps=0.003127867
Epoch 479: f= 647.107, eps=0.003284260
Epoch 480: f= 647.107, eps=0.003448473
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Epoch 482: f= 647.107, eps=0.003801941
Epoch 483: f= 647.107, eps=0.001900971
Epoch 484: f= 647.107, eps=0.001996019
Epoch 485: f= 647.107, eps=0.000998010
Epoch 486: f= 647.107, eps=0.001047910
Epoch 487: f= 647.107, eps=0.001100306
Epoch 488: f= 647.107, eps=0.001155321

Epoch 489: f= 647.107, eps=0.001213087
 Epoch 490: f= 647.107, eps=0.001273741
 Epoch 491: f= 647.107, eps=0.001337428
 Epoch 492: f= 647.107, eps=0.001404300
 Epoch 493: f= 647.107, eps=0.001474515
 Epoch 494: f= 647.107, eps=0.001548241
 Epoch 495: f= 647.107, eps=0.001625653
 Epoch 496: f= 647.107, eps=0.001706935
 Epoch 497: f= 647.107, eps=0.001792282
 Epoch 498: f= 647.107, eps=0.001881896
 Epoch 499: f= 647.107, eps=0.001975991
 Result after 500 epochs: f=647.1071050724063
 Epoch 0: f= 20184.264, eps=0.010000000
 Epoch 1: f=368036.938, eps=0.005000000
 Epoch 2: f=889328.801, eps=0.002500000
 Epoch 3: f= 73241.784, eps=0.002625000
 Epoch 4: f= 13981.321, eps=0.002756250
 Epoch 5: f= 8490.553, eps=0.002894063
 Epoch 6: f= 6650.629, eps=0.003038766
 Epoch 7: f= 11704.009, eps=0.001519383
 Epoch 8: f= 1047.754, eps=0.001595352
 Epoch 9: f= 788.589, eps=0.001675120
 Epoch 10: f= 837.627, eps=0.000837560
 Epoch 11: f= 756.173, eps=0.000879438
 Epoch 12: f= 751.407, eps=0.000923410
 Epoch 13: f= 751.226, eps=0.000969580
 Epoch 14: f= 751.212, eps=0.001018059
 Epoch 15: f= 751.210, eps=0.001068962
 Epoch 16: f= 751.210, eps=0.001122410
 Epoch 17: f= 751.210, eps=0.001178531
 Epoch 18: f= 751.210, eps=0.001237457
 Epoch 19: f= 751.210, eps=0.001299330
 Epoch 20: f= 751.210, eps=0.001364297
 Epoch 21: f= 751.210, eps=0.001432511
 Epoch 22: f= 751.210, eps=0.001504137
 Epoch 23: f= 751.210, eps=0.001579344
 Epoch 24: f= 751.210, eps=0.000789672
 Epoch 25: f= 751.210, eps=0.000829156
 Epoch 26: f= 751.210, eps=0.000870613
 Epoch 27: f= 751.210, eps=0.000914144
 Epoch 28: f= 751.210, eps=0.000959851
 Epoch 29: f= 751.210, eps=0.000479926
 Epoch 30: f= 751.210, eps=0.000503922
 Epoch 31: f= 751.210, eps=0.000529118
 Epoch 32: f= 751.210, eps=0.000555574
 Epoch 33: f= 751.210, eps=0.000583353
 Epoch 34: f= 751.210, eps=0.000612520
 Epoch 35: f= 751.210, eps=0.000643146

Epoch 36: f= 751.210, eps=0.000675303
Epoch 37: f= 751.210, eps=0.000709069
Epoch 38: f= 751.210, eps=0.000354534
Epoch 39: f= 751.210, eps=0.000372261
Epoch 40: f= 751.210, eps=0.000390874
Epoch 41: f= 751.210, eps=0.000410418
Epoch 42: f= 751.210, eps=0.000205209
Epoch 43: f= 751.210, eps=0.000215469
Epoch 44: f= 751.210, eps=0.000226243
Epoch 45: f= 751.210, eps=0.000237555
Epoch 46: f= 751.210, eps=0.000118777
Epoch 47: f= 751.210, eps=0.000124716
Epoch 48: f= 751.210, eps=0.000062358
Epoch 49: f= 751.210, eps=0.000065476
Epoch 50: f= 751.210, eps=0.000068750
Epoch 51: f= 751.210, eps=0.000072187
Epoch 52: f= 751.210, eps=0.000075797
Epoch 53: f= 751.210, eps=0.000037898
Epoch 54: f= 751.210, eps=0.000039793
Epoch 55: f= 751.210, eps=0.000041783
Epoch 56: f= 751.210, eps=0.000020891
Epoch 57: f= 751.210, eps=0.000021936
Epoch 58: f= 751.210, eps=0.000023033
Epoch 59: f= 751.210, eps=0.000011516
Epoch 60: f= 751.210, eps=0.000012092
Epoch 61: f= 751.210, eps=0.000012697
Epoch 62: f= 751.210, eps=0.000013332
Epoch 63: f= 751.210, eps=0.000013998
Epoch 64: f= 751.210, eps=0.000006999
Epoch 65: f= 751.210, eps=0.000007349
Epoch 66: f= 751.210, eps=0.000007717
Epoch 67: f= 751.210, eps=0.000003858
Epoch 68: f= 751.210, eps=0.000004051
Epoch 69: f= 751.210, eps=0.000004254
Epoch 70: f= 751.210, eps=0.000004466
Epoch 71: f= 751.210, eps=0.000002233
Epoch 72: f= 751.210, eps=0.000002345
Epoch 73: f= 751.210, eps=0.000002462
Epoch 74: f= 751.210, eps=0.000002585
Epoch 75: f= 751.210, eps=0.000001293
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Epoch 77: f= 751.210, eps=0.000001425
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Epoch 79: f= 751.210, eps=0.000000748
Epoch 80: f= 751.210, eps=0.000000374
Epoch 81: f= 751.210, eps=0.000000393
Epoch 82: f= 751.210, eps=0.000000412
Epoch 83: f= 751.210, eps=0.000000433

Epoch 84: f= 751.210, eps=0.000000455
Epoch 85: f= 751.210, eps=0.000000477
Epoch 86: f= 751.210, eps=0.000000501
Epoch 87: f= 751.210, eps=0.000000251
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Epoch 89: f= 751.210, eps=0.000000276
Epoch 90: f= 751.210, eps=0.000000290
Epoch 91: f= 751.210, eps=0.000000305
Epoch 92: f= 751.210, eps=0.000000320
Epoch 93: f= 751.210, eps=0.000000336
Epoch 94: f= 751.210, eps=0.000000353
Epoch 95: f= 751.210, eps=0.000000370
Epoch 96: f= 751.210, eps=0.000000389
Epoch 97: f= 751.210, eps=0.000000194
Epoch 98: f= 751.210, eps=0.000000204
Epoch 99: f= 751.210, eps=0.000000214
Epoch 100: f= 751.210, eps=0.000000225
Epoch 101: f= 751.210, eps=0.000000113
Epoch 102: f= 751.210, eps=0.000000118
Epoch 103: f= 751.210, eps=0.000000124
Epoch 104: f= 751.210, eps=0.000000130
Epoch 105: f= 751.210, eps=0.000000137
Epoch 106: f= 751.210, eps=0.000000144
Epoch 107: f= 751.210, eps=0.000000151
Epoch 108: f= 751.210, eps=0.000000158
Epoch 109: f= 751.210, eps=0.000000166
Epoch 110: f= 751.210, eps=0.000000175
Epoch 111: f= 751.210, eps=0.000000183
Epoch 112: f= 751.210, eps=0.000000192
Epoch 113: f= 751.210, eps=0.000000202
Epoch 114: f= 751.210, eps=0.000000212
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Epoch 116: f= 751.210, eps=0.000000111
Epoch 117: f= 751.210, eps=0.000000117
Epoch 118: f= 751.210, eps=0.000000123
Epoch 119: f= 751.210, eps=0.000000129
Epoch 120: f= 751.210, eps=0.000000135
Epoch 121: f= 751.210, eps=0.000000142
Epoch 122: f= 751.210, eps=0.000000149
Epoch 123: f= 751.210, eps=0.000000157
Epoch 124: f= 751.210, eps=0.000000165
Epoch 125: f= 751.210, eps=0.000000173
Epoch 126: f= 751.210, eps=0.000000181
Epoch 127: f= 751.210, eps=0.000000191
Epoch 128: f= 751.210, eps=0.000000200
Epoch 129: f= 751.210, eps=0.000000210
Epoch 130: f= 751.210, eps=0.000000221
Epoch 131: f= 751.210, eps=0.000000232

Epoch 132: f= 751.210, eps=0.000000243
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Epoch 135: f= 751.210, eps=0.000000282
Epoch 136: f= 751.210, eps=0.000000296
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Epoch 143: f= 751.210, eps=0.000000416
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Epoch 145: f= 751.210, eps=0.000000218
Epoch 146: f= 751.210, eps=0.000000229
Epoch 147: f= 751.210, eps=0.000000241
Epoch 148: f= 751.210, eps=0.000000253
Epoch 149: f= 751.210, eps=0.000000265
Epoch 150: f= 751.210, eps=0.000000279
Epoch 151: f= 751.210, eps=0.000000139
Epoch 152: f= 751.210, eps=0.000000146
Epoch 153: f= 751.210, eps=0.000000154
Epoch 154: f= 751.210, eps=0.000000161
Epoch 155: f= 751.210, eps=0.000000169
Epoch 156: f= 751.210, eps=0.000000178
Epoch 157: f= 751.210, eps=0.000000187
Epoch 158: f= 751.210, eps=0.000000196
Epoch 159: f= 751.210, eps=0.000000098
Epoch 160: f= 751.210, eps=0.000000103
Epoch 161: f= 751.210, eps=0.000000108
Epoch 162: f= 751.210, eps=0.000000113
Epoch 163: f= 751.210, eps=0.000000119
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Epoch 176: f= 751.210, eps=0.000000107
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Epoch 180: f= 751.210, eps=0.000000130
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Epoch 199: f= 751.210, eps=0.000000329
Epoch 200: f= 751.210, eps=0.000000164
Epoch 201: f= 751.210, eps=0.000000173
Epoch 202: f= 751.210, eps=0.000000181
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Epoch 204: f= 751.210, eps=0.000000200
Epoch 205: f= 751.210, eps=0.000000210
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Epoch 207: f= 751.210, eps=0.000000231
Epoch 208: f= 751.210, eps=0.000000243
Epoch 209: f= 751.210, eps=0.000000121
Epoch 210: f= 751.210, eps=0.000000127
Epoch 211: f= 751.210, eps=0.000000134
Epoch 212: f= 751.210, eps=0.000000141
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Epoch 214: f= 751.210, eps=0.000000155
Epoch 215: f= 751.210, eps=0.000000163
Epoch 216: f= 751.210, eps=0.000000171
Epoch 217: f= 751.210, eps=0.000000179
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Epoch 220: f= 751.210, eps=0.000000208
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Epoch 229: f= 751.210, eps=0.000000322
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Epoch 242: f= 751.210, eps=0.000000138
Epoch 243: f= 751.210, eps=0.000000145
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Epoch 256: f= 751.210, eps=0.000000062
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Epoch 268: f= 751.210, eps=0.000000111
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Epoch 270: f= 751.210, eps=0.000000122
Epoch 271: f= 751.210, eps=0.000000129
Epoch 272: f= 751.210, eps=0.000000135
Epoch 273: f= 751.210, eps=0.000000142
Epoch 274: f= 751.210, eps=0.000000149
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Epoch 281: f= 751.210, eps=0.000000100
Epoch 282: f= 751.210, eps=0.000000105
Epoch 283: f= 751.210, eps=0.000000110
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Epoch 285: f= 751.210, eps=0.000000121
Epoch 286: f= 751.210, eps=0.000000127
Epoch 287: f= 751.210, eps=0.000000134
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Epoch 289: f= 751.210, eps=0.000000147
Epoch 290: f= 751.210, eps=0.000000155
Epoch 291: f= 751.210, eps=0.000000162
Epoch 292: f= 751.210, eps=0.000000171
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Epoch 299: f= 751.210, eps=0.000000240
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Result after 500 epochs: f=751.2097111809543
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lambda 0.01: 320.1482561851763
lambda 0.1: 325.0589707546104
lambda 0.5: 338.1256197756515
lambda 1: 347.85049245754726
lambda 2: 361.1419871051869
lambda 3: 371.1389275935148
lambda 4: 379.44334033241876
lambda 5: 386.6645111344998
lambda 10: 414.11111711137437
lambda 20: 450.4792408532154
lambda 100: 575.9333931856461
lambda 200: 647.1071050724063
lambda 500: 751.2097111809543


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[324]: test_nll_results
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```

[illegible]

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[illegible]

[illegible]

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[illegible]

[illegible]

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```
[325]: test_nll
```

```
[326]: lambdas = list(test_nll_results.keys())
```

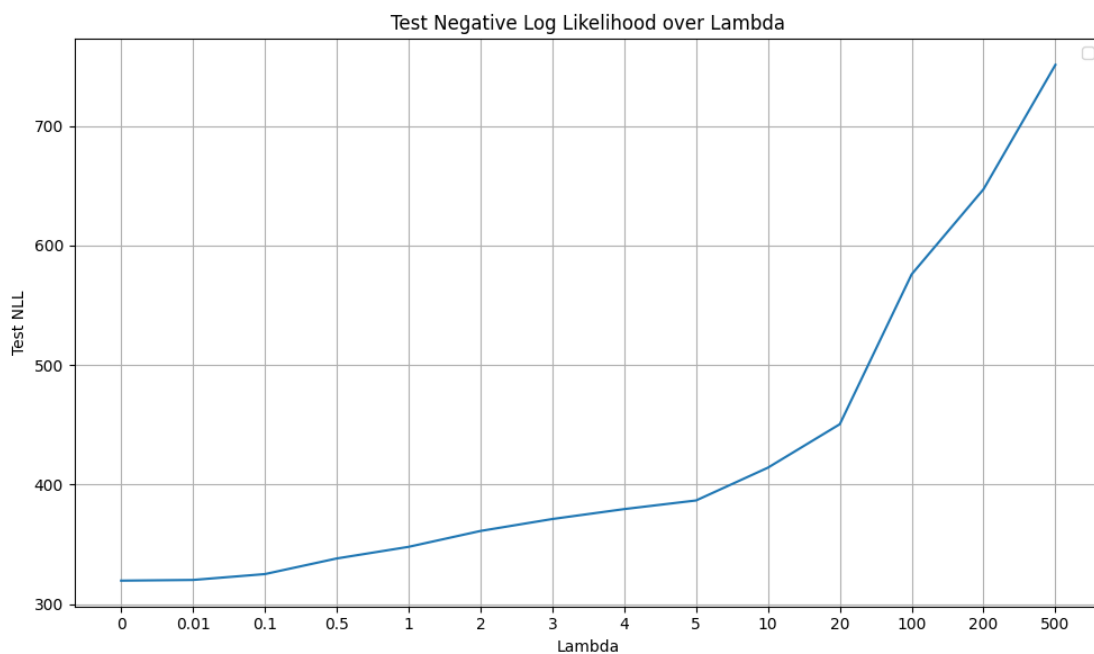
491

```
plt.title('Test Negative Log Likelihood over Lambda')
plt.legend()
plt.grid(True)

# Show the plot
plt.tight_layout()
plt.show()
```

/tmp/ipykernel_32055/2165311344.py:14: UserWarning: No artists with labels found to put in legend. Note that artists whose label start with an underscore are ignored when legend() is called with no argument.

```
plt.legend()
```



```
[328]: acc = {}
for la in lam_values:
    yh = predict(Xtestz, results[str(la)]["final_weights"])
    yp = classify(Xtestz, results[str(la)]["final_weights"])
    metrics = sklearn.metrics.classification_report(ytest, yp, output_dict=True)
    acc[la] = metrics['accuracy']
```

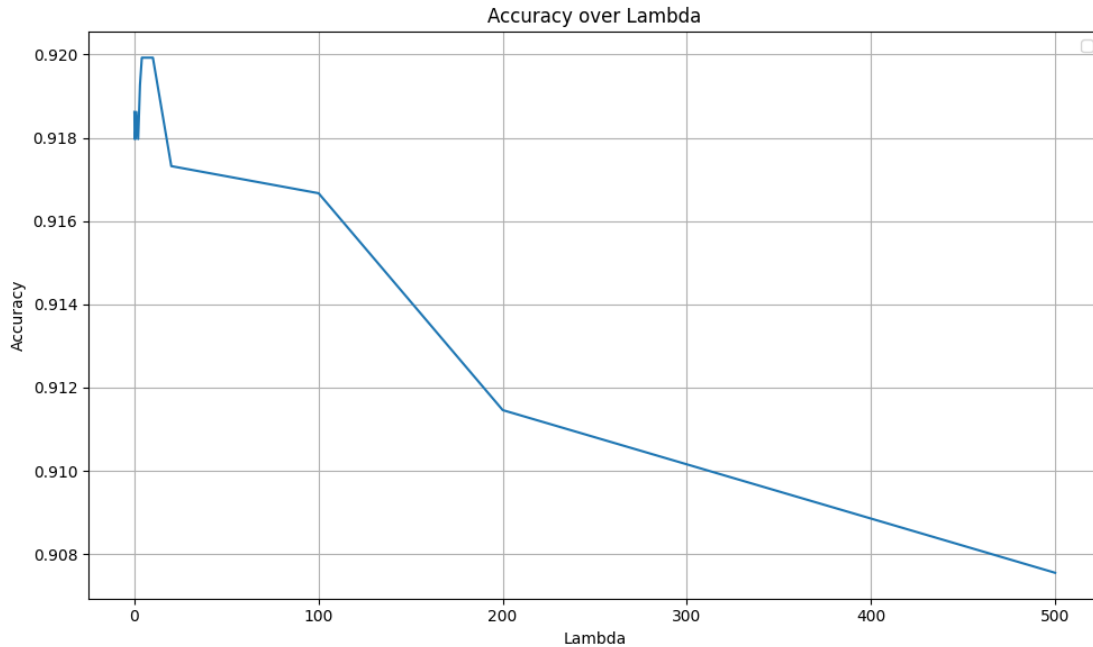
```
[329]: acc
```

```
[329]: {0: 0.9186197916666666,
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4: 0.919921875,  
5: 0.919921875,  
10: 0.919921875,  
20: 0.9173177083333334,  
100: 0.9166666666666666,  
200: 0.9114583333333334,  
500: 0.9075520833333334}
```

```
[330]: lambdas = list(acc.keys())  
  
# Extracting values for plotting  
accuracies = [acc[lam] for lam in lambdas]  
# Setting up the scatter plot  
plt.figure(figsize=(10, 6))  
  
plt.plot(lambdas, accuracies)  
  
# Adding labels and title  
plt.xlabel('Lambda')  
plt.ylabel('Accuracy')  
plt.title('Accuracy over Lambda')  
plt.legend()  
plt.grid(True)  
  
# Show the plot  
plt.tight_layout()  
plt.show()
```

```
/tmp/ipykernel_32055/2620896624.py:14: UserWarning: No artists with labels found  
to put in legend. Note that artists whose label start with an underscore are  
ignored when legend() is called with no argument.  
plt.legend()
```



8.3 4c Composition of Weight Vector

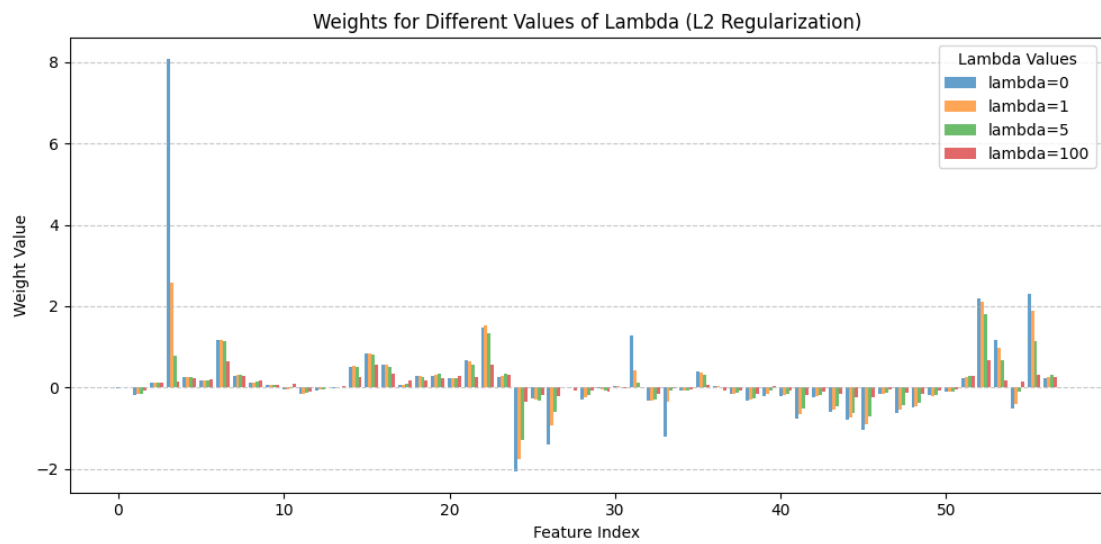
```
[331]: # YOUR CODE HERE
nextplot()
plt.figure(figsize=(10, 5))

# Plot bars with different offsets to avoid overlap
bar_width = 0.2 # Width of each bar

plt.bar(np.arange(D), results['0']['final_weights'], width=bar_width,
        label='lambda=0', alpha=0.7)
plt.bar(np.arange(D) + bar_width, results['1']['final_weights'],
        width=bar_width, label='lambda=1', alpha=0.7)
plt.bar(np.arange(D) + 2 * bar_width, results['5']['final_weights'],
        width=bar_width, label='lambda=5', alpha=0.7)
plt.bar(np.arange(D) + 3 * bar_width, results['100']['final_weights'],
        width=bar_width, label='lambda=100', alpha=0.7)

# Add labels and title
plt.xlabel("Feature Index")
plt.ylabel("Weight Value")
plt.title("Weights for Different Values of Lambda (L2 Regularization)")
plt.legend(title="Lambda Values")
plt.grid(axis="y", linestyle="--", alpha=0.7) # Add grid for easier comparison
plt.tight_layout()
```

```
plt.show()
```



8.4 5 Exploration (optional)

8.4.1 5 Exploration: PyTorch

```
[332]: !pip install torch
```

```
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/home/tu2/anaconda3/envs/ml/lib/python3.10/site-packages (2.4.1)
Requirement already satisfied: filelock in /home/tu2/.local/lib/python3.10/site-
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Requirement already satisfied: typing-extensions>=4.8.0 in
/home/tu2/anaconda3/envs/ml/lib/python3.10/site-packages (from torch) (4.12.2)
Requirement already satisfied: sympy in /home/tu2/.local/lib/python3.10/site-
packages (from torch) (1.12)
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packages (from torch) (3.1)
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Requirement already satisfied: nvidia-nvtx-cu12==12.1.105 in
/home/tu2/anaconda3/envs/ml/lib/python3.10/site-packages (from torch) (12.1.105)
Requirement already satisfied: triton==3.0.0 in
/home/tu2/anaconda3/envs/ml/lib/python3.10/site-packages (from torch) (3.0.0)
```


Requirement already satisfied: nvidia-nvjitlink-cu12 in
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cu12==11.4.5.107->torch) (12.6.68)
Requirement already satisfied: MarkupSafe>=2.0 in
/home/tu2/.local/lib/python3.10/site-packages (from jinja2->torch) (2.1.3)
Requirement already satisfied: mpmath>=0.19 in
/home/tu2/.local/lib/python3.10/site-packages (from sympy->torch) (1.3.0)

```
[333]: # if you want to experiment, here is an implementation of logistic  
# regression in PyTorch  
import math  
import torch  
import torch.nn as nn  
import torch.utils.data  
import torch.nn.functional as F  
  
# prepare the data  
Xztorch = torch.FloatTensor(Xz)  
ytorch = torch.LongTensor(y)  
train = torch.utils.data.TensorDataset(Xztorch, ytorch)  
  
# manual implementation of logistic regression (without bias)  
class LogisticRegression(nn.Module):  
    def __init__(self, D, C):  
        super(LogisticRegression, self).__init__()  
        self.weights = torch.nn.Parameter(  
            torch.randn(D, C) / math.sqrt(D)  
        ) # xavier initialization  
        self.register_parameter("W", self.weights)  
  
    def forward(self, x):  
        out = torch.matmul(x, self.weights)  
        out = F.log_softmax(out)  
        return out  
  
# define the objective and update function. here we ignore the learning rates  
# and parameters given to us by optimize (they are stored in the PyTorch model  
# and optimizer, resp., instead)  
def opt_pytorch():  
    model = LogisticRegression(D, 2)  
    criterion = nn.NLLLoss(reduction="sum")  
    # change the next line to try different optimizers  
    # optimizer = torch.optim.SGD(model.parameters(), lr=learning_rate)  
    optimizer = torch.optim.Adam(model.parameters(), lr=learning_rate)
```

```

def objective(_):
    outputs = model(Xztorch)
    return criterion(outputs, ytorch)

def update(_1, _2):
    for i, (examples, labels) in enumerate(train_loader):
        outputs = model(examples)
        loss = criterion(outputs, labels)
        optimizer.zero_grad()
        loss.backward()
        optimizer.step()

    W = model.state_dict()["W"]
    w = W[:, 1] - W[:, 0]
    return w

return (objective, update)

```

```

[334]: # run the optimizer
learning_rate = 0.01
batch_size = 100 # number of data points to sample for gradient estimate
shuffle = True # sample with replacement (false) or without replacement (true)

train_loader = torch.utils.data.DataLoader(train, batch_size, shuffle=True)
wz_t, vz_t, _ = optimize(opt_pytorch(), None, nepochs=100, eps0=None,
↳ verbose=True)

```

/tmp/ipykernel_32055/2194961090.py:26: UserWarning: Implicit dimension choice for log_softmax has been deprecated. Change the call to include dim=X as an argument.

```
out = F.log_softmax(out)
```

Epoch	0:	f=	2167.742,	eps=	nan
Epoch	1:	f=	858.704,	eps=	nan
Epoch	2:	f=	776.136,	eps=	nan
Epoch	3:	f=	741.471,	eps=	nan
Epoch	4:	f=	723.754,	eps=	nan
Epoch	5:	f=	711.613,	eps=	nan
Epoch	6:	f=	703.819,	eps=	nan
Epoch	7:	f=	697.749,	eps=	nan
Epoch	8:	f=	693.980,	eps=	nan
Epoch	9:	f=	689.839,	eps=	nan
Epoch	10:	f=	686.455,	eps=	nan
Epoch	11:	f=	685.140,	eps=	nan
Epoch	12:	f=	682.958,	eps=	nan
Epoch	13:	f=	681.823,	eps=	nan
Epoch	14:	f=	681.342,	eps=	nan
Epoch	15:	f=	678.672,	eps=	nan

Epoch	16:	f=	678.164,	eps=	nan
Epoch	17:	f=	677.424,	eps=	nan
Epoch	18:	f=	676.983,	eps=	nan
Epoch	19:	f=	675.968,	eps=	nan
Epoch	20:	f=	676.158,	eps=	nan
Epoch	21:	f=	675.512,	eps=	nan
Epoch	22:	f=	675.020,	eps=	nan
Epoch	23:	f=	674.520,	eps=	nan
Epoch	24:	f=	674.022,	eps=	nan
Epoch	25:	f=	673.802,	eps=	nan
Epoch	26:	f=	673.689,	eps=	nan
Epoch	27:	f=	673.208,	eps=	nan
Epoch	28:	f=	673.288,	eps=	nan
Epoch	29:	f=	672.501,	eps=	nan
Epoch	30:	f=	672.435,	eps=	nan
Epoch	31:	f=	672.252,	eps=	nan
Epoch	32:	f=	671.503,	eps=	nan
Epoch	33:	f=	671.300,	eps=	nan
Epoch	34:	f=	671.908,	eps=	nan
Epoch	35:	f=	671.844,	eps=	nan
Epoch	36:	f=	671.182,	eps=	nan
Epoch	37:	f=	670.691,	eps=	nan
Epoch	38:	f=	670.405,	eps=	nan
Epoch	39:	f=	671.025,	eps=	nan
Epoch	40:	f=	670.754,	eps=	nan
Epoch	41:	f=	669.944,	eps=	nan
Epoch	42:	f=	669.227,	eps=	nan
Epoch	43:	f=	669.309,	eps=	nan
Epoch	44:	f=	669.374,	eps=	nan
Epoch	45:	f=	668.963,	eps=	nan
Epoch	46:	f=	669.855,	eps=	nan
Epoch	47:	f=	669.853,	eps=	nan
Epoch	48:	f=	668.648,	eps=	nan
Epoch	49:	f=	668.168,	eps=	nan
Epoch	50:	f=	668.196,	eps=	nan
Epoch	51:	f=	668.369,	eps=	nan
Epoch	52:	f=	667.841,	eps=	nan
Epoch	53:	f=	668.308,	eps=	nan
Epoch	54:	f=	667.862,	eps=	nan
Epoch	55:	f=	667.308,	eps=	nan
Epoch	56:	f=	667.335,	eps=	nan
Epoch	57:	f=	666.495,	eps=	nan
Epoch	58:	f=	668.021,	eps=	nan
Epoch	59:	f=	666.829,	eps=	nan
Epoch	60:	f=	666.158,	eps=	nan
Epoch	61:	f=	666.187,	eps=	nan
Epoch	62:	f=	666.081,	eps=	nan
Epoch	63:	f=	665.798,	eps=	nan

```
Epoch 64: f= 665.544, eps= nan
Epoch 65: f= 665.496, eps= nan
Epoch 66: f= 666.050, eps= nan
Epoch 67: f= 665.503, eps= nan
Epoch 68: f= 664.774, eps= nan
Epoch 69: f= 665.563, eps= nan
Epoch 70: f= 664.641, eps= nan
Epoch 71: f= 665.250, eps= nan
Epoch 72: f= 664.187, eps= nan
Epoch 73: f= 664.695, eps= nan
Epoch 74: f= 663.757, eps= nan
Epoch 75: f= 664.139, eps= nan
Epoch 76: f= 664.565, eps= nan
Epoch 77: f= 663.946, eps= nan
Epoch 78: f= 663.746, eps= nan
Epoch 79: f= 664.476, eps= nan
Epoch 80: f= 662.315, eps= nan
Epoch 81: f= 663.081, eps= nan
Epoch 82: f= 662.142, eps= nan
Epoch 83: f= 662.654, eps= nan
Epoch 84: f= 663.786, eps= nan
Epoch 85: f= 662.094, eps= nan
Epoch 86: f= 661.566, eps= nan
Epoch 87: f= 661.118, eps= nan
Epoch 88: f= 661.899, eps= nan
Epoch 89: f= 662.141, eps= nan
Epoch 90: f= 661.724, eps= nan
Epoch 91: f= 661.799, eps= nan
Epoch 92: f= 660.493, eps= nan
Epoch 93: f= 660.781, eps= nan
Epoch 94: f= 660.424, eps= nan
Epoch 95: f= 660.235, eps= nan
Epoch 96: f= 659.848, eps= nan
Epoch 97: f= 659.318, eps= nan
Epoch 98: f= 659.318, eps= nan
Epoch 99: f= 658.994, eps= nan
Result after 100 epochs: f=659.8973388671875
```

[]: