Part I Softmax Regression

Qsr1

(1) Show that probabilities sum to 1

$$P[y=1] = \frac{1}{1+e^{-\vec{w}\cdot\vec{x}}} = \frac{e^{\vec{w}\cdot\vec{x}}}{e^{\vec{w}\cdot\vec{x}}+e^{\vec{0}\cdot\vec{x}}}$$

$$P[y=0] = 1 - \frac{1}{1+e^{-\vec{w}\cdot\vec{x}}} = \frac{e^{\vec{0}\cdot\vec{x}}}{e^{\vec{w}\cdot\vec{x}}+e^{\vec{0}\cdot\vec{x}}}$$

$$P[y=i] = \frac{e^{\vec{w_i}\cdot\vec{x}}}{\sum_j e^{\vec{w_j}\cdot\vec{x}}}$$

Summing all probabilities:

$$\sum_i P[y=i] = \sum_i \frac{e^{\vec{w_i}\cdot\vec{x}}}{\sum_j e^{\vec{w_j}\cdot\vec{x}}} = \frac{\sum_i e^{\vec{w_i}\cdot\vec{x}}}{\sum_j e^{\vec{w_j}\cdot\vec{x}}} = 1$$

Proven.

(2) What are the dimensions of W? X? WX?

$\vec{x_i}$ is n dimensional.\ Thus $\vec{x_i}$ is a $(1 \times n)$ matrix.

Say we have m classes.\ Then W is a $(n \times m)$ matrix.

Say we have p examples.\ Then X is a $(p \times n)$ matrix.

Thus WX is a $(p \times m)$ matrix.

Qsr2: code

Qsr3

In the cost function, we see the line

```
W_X = W_X - np.max(W_X)
```

This means that each entry is reduced by the largest entry in the matrix.

(1) Show that this does not affect the predicted probabilities.

We are given from above that probability is:

$$P[y=i] = \frac{e^{\vec{w}_i \cdot \vec{x}}}{\sum_j e^{\vec{w}_j \cdot \vec{x}}}$$

We can write that code line above as

$$WX = WX - \max(WX)$$

Manipulating the probability equation:

$$P[y=i] = \frac{\left(\frac{1}{e^{\max(WX)}}\right)}{\left(\frac{1}{e^{\max(WX)}}\right)} \frac{e^{\vec{w}_i \cdot \vec{x}}}{\sum_j e^{\vec{w}_j \cdot \vec{x}}} \tag{1}$$

$$= \frac{e^{\vec{w}_i \cdot \vec{x} - \max(WX)}}{\sum_j e^{\vec{w}_j \cdot \vec{x} - \max(WX)}} \tag{2}$$

Therefore, the probability is not affected by the subtraction of the maximum.

(2) Why might this be an optimization over using W_X? Justify your answer.

Calculating any exponential can result in huge numbers, and may result in buffer overflow. Dividing a huge number is computationally difficult as well. The usage of $\max(WX)$ is to reduce the size of the exponential, and thus reduce the computational cost.

Qsr4

Use the `learningCurve` function in `runClassifier.py` to plot the accuracy of the classifier as a function of the number of examples seen. Include the plot in your write-up. Do you observe any overfitting or underfitting? Discuss and expain what you observe.

In [ ]:
```
from runClassifier import *
from softmax import *
from utils import *
# use the learningCurve function in runClassifier.py to plot the learning
# on the provided data. You should see a plot similar to the one in the w
exSize = 28*28
numClasses = 10
reg = 0.0001
X, Y = loadMNIST('data/train-images.idx3-ubyte', 'data/train-labels.idx1-
testX, testY = loadMNIST('data/t10k-images.idx3-ubyte', 'data/t10k-labels
dataSizes, trainAcc, testAcc = learningCurve(SoftmaxRegression(numClasses
```

```
60000
16
1
(784, 2)
(2,)
Training classifier on 2 points...
RUNNING THE L-BFGS-B CODE

           * * *

Machine precision = 2.220D-16
 N =         7840     M =           10

At X0         0 variables are exactly at the bounds

At iterate    0    f=  3.45388D+00    |proj g|=  4.50000D-01

At iterate    1    f=  7.54791D-01    |proj g|=  2.56845D-01

At iterate    2    f=  7.35419D-01    |proj g|=  2.49947D-01

At iterate    3    f=  6.93397D-01    |proj g|=  2.49922D-01

           * * *

Tit   = total number of iterations
Tnf   = total number of function evaluations
Tnint = total number of segments explored during Cauchy searches
Skip  = number of BFGS updates skipped
Nact  = number of active bounds at final generalized Cauchy point
Projg = norm of the final projected gradient
F     = final function value

           * * *

   N    Tit     Tnf  Tnint  Skip  Nact     Projg        F
 7840      4     59      2     0     0   2.499D-01   6.934D-01
  F =  0.69339723797348007

ABNORMAL_TERMINATION_IN_LNSRCH
Training accuracy 1, test accuracy 0.1048
2
(784, 4)
(4,)
```

```
Training classifier on 4 points...
RUNNING THE L-BFGS-B CODE

           * * *

Machine precision = 2.220D-16
 N =         7840     M =           10

At X0         0 variables are exactly at the bounds

At iterate    0    f=  1.40360D+00    |proj g|=  4.37973D-01

At iterate    1    f=  3.61703D-01    |proj g|=  1.24020D-01

At iterate    2    f=  3.46576D-01    |proj g|=  1.24999D-01

           * * *

Tit   = total number of iterations
Tnf   = total number of function evaluations
Tnint = total number of segments explored during Cauchy searches
Skip  = number of BFGS updates skipped
Nact  = number of active bounds at final generalized Cauchy point
Projg = norm of the final projected gradient
F     = final function value

           * * *

   N    Tit     Tnf  Tnint  Skip  Nact     Projg        F
 7840      3     51      2     0     0   1.250D-01   3.466D-01
  F =  0.34657562925118829

ABNORMAL_TERMINATION_IN_LNSRCH
Training accuracy 1, test accuracy 0.1389
3
(784, 8)
(8,)
Training classifier on 8 points...
RUNNING THE L-BFGS-B CODE

           * * *

Machine precision = 2.220D-16
 N =         7840     M =           10

At X0         0 variables are exactly at the bounds

At iterate    0    f=  1.77493D+01    |proj g|=  2.09057D-01

At iterate    1    f=  1.53034D+01    |proj g|=  1.95530D-01

At iterate    2    f=  2.03323D+00    |proj g|=  1.25000D-01

At iterate    3    f=  3.48882D-01    |proj g|=  1.16768D-01

At iterate    4    f=  4.92696D-03    |proj g|=  4.81313D-03
```

```
At iterate    5    f=  3.47600D-03    |proj g|=  3.41517D-03

At iterate    6    f=  1.47469D-03    |proj g|=  1.46037D-03

At iterate    7    f=  7.75579D-04    |proj g|=  7.70153D-04

At iterate    8    f=  3.78640D-04    |proj g|=  3.76565D-04

At iterate    9    f=  1.90897D-04    |proj g|=  1.89977D-04

At iterate   10    f=  9.52518D-05    |proj g|=  9.48150D-05

At iterate   11    f=  4.77882D-05    |proj g|=  4.75650D-05

At iterate   12    f=  2.39576D-05    |proj g|=  2.38353D-05

At iterate   13    f=  1.20328D-05    |proj g|=  1.19597D-05

At iterate   14    f=  6.05174D-06    |proj g|=  6.00330D-06

           * * *

Tit   = total number of iterations
Tnf   = total number of function evaluations
Tnint = total number of segments explored during Cauchy searches
Skip  = number of BFGS updates skipped
Nact  = number of active bounds at final generalized Cauchy point
Projg = norm of the final projected gradient
F     = final function value

           * * *

   N    Tit     Tnf  Tnint  Skip  Nact     Projg        F
 7840     14     15      1     0     0   6.003D-06   6.052D-06
  F =   6.0517408407428233E-006

CONVERGENCE: NORM_OF_PROJECTED_GRADIENT_<=_PGTOL
Training accuracy 1, test accuracy 0.2692
4
(784, 15)
(15,)
Training classifier on 15 points...
RUNNING THE L-BFGS-B CODE

           * * *

Machine precision = 2.220D-16
 N =         7840     M =           10

At X0         0 variables are exactly at the bounds

At iterate    0    f=  5.11229D+00    |proj g|=  1.76880D-01

At iterate    1    f=  3.35493D+00    |proj g|=  1.26666D-01

At iterate    2    f=  2.27328D+00    |proj g|=  1.55596D-01
```

```
At iterate    3    f=  1.24779D-01    |proj g|=  6.98760D-02

At iterate    4    f=  1.44288D-03    |proj g|=  1.34479D-03

At iterate    5    f=  1.22054D-03    |proj g|=  1.12981D-03

At iterate    6    f=  6.59546D-04    |proj g|=  5.84783D-04

At iterate    7    f=  3.96179D-04    |proj g|=  3.29367D-04

At iterate    8    f=  2.22890D-04    |proj g|=  1.64677D-04

At iterate    9    f=  1.31249D-04    |proj g|=  8.30030D-05

At iterate   10    f=  7.61479D-05    |proj g|=  4.03260D-05

At iterate   11    f=  4.27334D-05    |proj g|=  1.95979D-05

At iterate   12    f=  2.29767D-05    |proj g|=  1.01193D-05

At iterate   13    f=  1.22311D-05    |proj g|=  5.25885D-06

           * * *

Tit   = total number of iterations
Tnf   = total number of function evaluations
Tnint = total number of segments explored during Cauchy searches
Skip  = number of BFGS updates skipped
Nact  = number of active bounds at final generalized Cauchy point
Projg = norm of the final projected gradient
F     = final function value

           * * *

   N    Tit     Tnf  Tnint  Skip  Nact     Projg        F
 7840     13     14      1     0     0   5.259D-06   1.223D-05
  F =   1.2231068946605654E-005

CONVERGENCE: NORM_OF_PROJECTED_GRADIENT_<=_PGTOL
Training accuracy 1, test accuracy 0.3502
5
(784, 30)
(30,)
Training classifier on 30 points...
RUNNING THE L-BFGS-B CODE

           * * *

Machine precision = 2.220D-16
 N =         7840     M =           10

At X0         0 variables are exactly at the bounds

At iterate    0    f=  5.69010D+00    |proj g|=  9.86926D-02

At iterate    1    f=  4.51942D+00    |proj g|=  9.86915D-02
```

```
At iterate    2    f=  1.44265D+00    |proj g|=  1.19933D-01

At iterate    3    f=  2.35187D-01    |proj g|=  5.25363D-02

At iterate    4    f=  1.11300D-01    |proj g|=  3.17428D-02

At iterate    5    f=  5.06836D-03    |proj g|=  2.25584D-03

At iterate    6    f=  4.11126D-03    |proj g|=  1.55607D-03

At iterate    7    f=  2.39175D-03    |proj g|=  6.98630D-04

At iterate    8    f=  1.45891D-03    |proj g|=  4.23961D-04

At iterate    9    f=  8.17487D-04    |proj g|=  2.27433D-04

At iterate   10    f=  4.48764D-04    |proj g|=  1.20477D-04

At iterate   11    f=  2.34866D-04    |proj g|=  6.06628D-05

At iterate   12    f=  1.24037D-04    |proj g|=  2.94642D-05
```

```
 This problem is unconstrained.
/Users/andreanpriadi/Documents/Academic/UMD/CMSC422-MachineLearning/cmsc-
422-introduction-to-machine-learning/p3/softmax.py:98: RuntimeWarning: in
valid value encountered in divide
  probabilities = np.exp(W_X) / np.sum(np.exp(W_X), axis=0)
/Users/andreanpriadi/Documents/Academic/UMD/CMSC422-MachineLearning/cmsc-
422-introduction-to-machine-learning/p3/softmax.py:99: RuntimeWarning: di
vide by zero encountered in log
  cost = -1 * np.sum(np.multiply(np.log(probabilities), indicator)) / N
/Users/andreanpriadi/Documents/Academic/UMD/CMSC422-MachineLearning/cmsc-
422-introduction-to-machine-learning/p3/softmax.py:99: RuntimeWarning: in
valid value encountered in log
  cost = -1 * np.sum(np.multiply(np.log(probabilities), indicator)) / N
/Users/andreanpriadi/Documents/Academic/UMD/CMSC422-MachineLearning/cmsc-
422-introduction-to-machine-learning/p3/softmax.py:99: RuntimeWarning: in
valid value encountered in multiply
  cost = -1 * np.sum(np.multiply(np.log(probabilities), indicator)) / N

 Bad direction in the line search;
   refresh the lbfgs memory and restart the iteration.

 Line search cannot locate an adequate point after MAXLS
  function and gradient evaluations.
  Previous x, f and g restored.
 Possible causes: 1 error in function or gradient evaluation;
                  2 rounding error dominate computation.
 This problem is unconstrained.

 Bad direction in the line search;
   refresh the lbfgs memory and restart the iteration.

 Line search cannot locate an adequate point after MAXLS
  function and gradient evaluations.
  Previous x, f and g restored.
 Possible causes: 1 error in function or gradient evaluation;
                  2 rounding error dominate computation.
 This problem is unconstrained.
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 This problem is unconstrained.
At iterate   13    f=  6.69782D-05    |proj g|=  1.52075D-05

At iterate   14    f=  3.69401D-05    |proj g|=  8.24258D-06

           * * *

Tit   = total number of iterations
Tnf   = total number of function evaluations
Tnint = total number of segments explored during Cauchy searches
Skip  = number of BFGS updates skipped
Nact  = number of active bounds at final generalized Cauchy point
Projg = norm of the final projected gradient
F     = final function value

           * * *

   N    Tit     Tnf  Tnint  Skip  Nact     Projg        F
 7840     14     15      1     0     0   8.243D-06   3.694D-05
```

```
  F =   3.6940080143605852E-005

CONVERGENCE: NORM_OF_PROJECTED_GRADIENT_<=_PGTOL
Training accuracy 1, test accuracy 0.4004
6
(784, 59)
(59,)
Training classifier on 59 points...
RUNNING THE L-BFGS-B CODE

           * * *

Machine precision = 2.220D-16
 N =         7840     M =           10

At X0         0 variables are exactly at the bounds

At iterate    0    f=  2.63305D+00    |proj g|=  8.05740D-02

At iterate    1    f=  1.77657D+00    |proj g|=  4.96180D-02

At iterate    2    f=  1.08953D+00    |proj g|=  6.26937D-02

At iterate    3    f=  6.01203D-01    |proj g|=  2.53500D-02

At iterate    4    f=  3.13405D-01    |proj g|=  2.25235D-02

At iterate    5    f=  3.48546D-02    |proj g|=  1.07624D-02

At iterate    6    f=  1.11223D-02    |proj g|=  2.11728D-03

At iterate    7    f=  7.12372D-03    |proj g|=  1.39069D-03

At iterate    8    f=  3.68016D-03    |proj g|=  8.77377D-04

At iterate    9    f=  1.87058D-03    |proj g|=  4.96812D-04

At iterate   10    f=  1.23280D-03    |proj g|=  2.62562D-04

At iterate   11    f=  7.52213D-04    |proj g|=  1.30102D-04

At iterate   12    f=  4.42241D-04    |proj g|=  6.54976D-05

At iterate   13    f=  2.41959D-04    |proj g|=  3.23871D-05

At iterate   14    f=  1.29249D-04    |proj g|=  1.74530D-05

At iterate   15    f=  8.02618D-05    |proj g|=  3.50358D-05

At iterate   16    f=  3.05624D-05    |proj g|=  4.88372D-06

           * * *

Tit   = total number of iterations
Tnf   = total number of function evaluations
Tnint = total number of segments explored during Cauchy searches
Skip  = number of BFGS updates skipped
```

```
Nact  = number of active bounds at final generalized Cauchy point
Projg = norm of the final projected gradient
F     = final function value

           * * *

   N    Tit     Tnf  Tnint  Skip  Nact     Projg        F
 7840     16     17      1     0     0   4.884D-06   3.056D-05
  F =   3.0562412317296804E-005

CONVERGENCE: NORM_OF_PROJECTED_GRADIENT_<=_PGTOL
Training accuracy 1, test accuracy 0.5819
7
(784, 118)
(118,)
Training classifier on 118 points...
RUNNING THE L-BFGS-B CODE

           * * *

Machine precision = 2.220D-16
 N =         7840     M =           10

At X0         0 variables are exactly at the bounds

At iterate    0    f=  1.99178D+00    |proj g|=  4.68696D-02

At iterate    1    f=  1.44924D+00    |proj g|=  3.09946D-02

At iterate    2    f=  9.85280D-01    |proj g|=  6.24452D-02

At iterate    3    f=  6.45540D-01    |proj g|=  3.73655D-02

At iterate    4    f=  4.11109D-01    |proj g|=  2.28940D-02

At iterate    5    f=  2.45314D-01    |proj g|=  1.91733D-02

At iterate    6    f=  8.98552D-02    |proj g|=  9.57844D-03

At iterate    7    f=  5.13959D-02    |proj g|=  1.92617D-02

At iterate    8    f=  8.05702D-03    |proj g|=  2.17717D-03

At iterate    9    f=  5.82053D-03    |proj g|=  1.29315D-03

At iterate   10    f=  4.90646D-03    |proj g|=  1.02046D-03

At iterate   11    f=  3.05427D-03    |proj g|=  4.44452D-04

At iterate   12    f=  1.96168D-03    |proj g|=  2.77390D-04

At iterate   13    f=  1.12779D-03    |proj g|=  1.43559D-04

At iterate   14    f=  6.71043D-04    |proj g|=  6.79248D-05

At iterate   15    f=  4.12220D-04    |proj g|=  1.16139D-04
```

```
At iterate   16    f=  2.15119D-04    |proj g|=  2.46887D-05

At iterate   17    f=  1.58105D-04    |proj g|=  1.81067D-05

At iterate   18    f=  8.12519D-05    |proj g|=  1.07499D-05

At iterate   19    f=  5.57072D-05    |proj g|=  1.95780D-05

At iterate   20    f=  2.69800D-05    |proj g|=  4.44389D-06

           * * *

Tit   = total number of iterations
Tnf   = total number of function evaluations
Tnint = total number of segments explored during Cauchy searches
Skip  = number of BFGS updates skipped
Nact  = number of active bounds at final generalized Cauchy point
Projg = norm of the final projected gradient
F     = final function value

           * * *

   N    Tit     Tnf  Tnint  Skip  Nact     Projg        F
 7840     20     21      1     0     0   4.444D-06   2.698D-05
  F =   2.6980015528677725E-005

CONVERGENCE: NORM_OF_PROJECTED_GRADIENT_<=_PGTOL
Training accuracy 1, test accuracy 0.7018
8
(784, 235)
(235,)
Training classifier on 235 points...
RUNNING THE L-BFGS-B CODE

           * * *

Machine precision = 2.220D-16
 N =         7840     M =           10

At X0         0 variables are exactly at the bounds

At iterate    0    f=  1.47343D+00    |proj g|=  3.22743D-02

At iterate    1    f=  1.18133D+00    |proj g|=  2.45324D-02

At iterate    2    f=  8.43887D-01    |proj g|=  2.67739D-02

At iterate    3    f=  5.21751D-01    |proj g|=  4.18095D-02

At iterate    4    f=  2.89418D-01    |proj g|=  1.23715D-02

At iterate    5    f=  2.26249D-01    |proj g|=  8.73027D-03

At iterate    6    f=  1.12915D-01    |proj g|=  7.24808D-03

At iterate    7    f=  8.87794D-02    |proj g|=  1.22744D-02
```

```
At iterate    8    f=  5.43749D-02    |proj g|=  4.39127D-03

At iterate    9    f=  3.23356D-02    |proj g|=  4.52646D-03

At iterate   10    f=  1.87081D-02    |proj g|=  4.11491D-03

At iterate   11    f=  5.78464D-03    |proj g|=  1.68456D-03

At iterate   12    f=  4.16402D-03    |proj g|=  7.71438D-04

At iterate   13    f=  2.95909D-03    |proj g|=  3.44616D-04

At iterate   14    f=  2.11762D-03    |proj g|=  2.38869D-04

At iterate   15    f=  1.42593D-03    |proj g|=  1.46607D-04

At iterate   16    f=  8.64880D-04    |proj g|=  1.03651D-04

At iterate   17    f=  5.07011D-04    |proj g|=  7.38319D-05

At iterate   18    f=  3.23099D-04    |proj g|=  2.01068D-05

At iterate   19    f=  2.34474D-04    |proj g|=  1.83593D-05

At iterate   20    f=  1.33032D-04    |proj g|=  1.12012D-05

At iterate   21    f=  9.21129D-05    |proj g|=  2.01157D-05

At iterate   22    f=  5.19530D-05    |proj g|=  5.48372D-06

           * * *

Tit   = total number of iterations
Tnf   = total number of function evaluations
Tnint = total number of segments explored during Cauchy searches
Skip  = number of BFGS updates skipped
Nact  = number of active bounds at final generalized Cauchy point
Projg = norm of the final projected gradient
F     = final function value

           * * *

   N    Tit     Tnf  Tnint  Skip  Nact     Projg        F
 7840     22     23      1     0     0   5.484D-06   5.195D-05
  F =   5.1952951834531122E-005

CONVERGENCE: NORM_OF_PROJECTED_GRADIENT_<=_PGTOL
Training accuracy 1, test accuracy 0.793
9
(784, 469)
(469,)
Training classifier on 469 points...
RUNNING THE L-BFGS-B CODE

           * * *

Machine precision = 2.220D-16
```

```
 N =         7840     M =           10

At X0         0 variables are exactly at the bounds

At iterate    0    f=  1.04250D+00    |proj g|=  2.10990D-02

At iterate    1    f=  8.31139D-01    |proj g|=  1.53740D-02

At iterate    2    f=  6.07346D-01    |proj g|=  2.75524D-02

At iterate    3    f=  4.19349D-01    |proj g|=  1.48126D-02

At iterate    4    f=  2.75766D-01    |proj g|=  1.25437D-02

 This problem is unconstrained.
 This problem is unconstrained.
 This problem is unconstrained.
 This problem is unconstrained.
At iterate    5    f=  1.92107D-01    |proj g|=  1.77812D-02

At iterate    6    f=  1.16011D-01    |proj g|=  9.31120D-03

At iterate    7    f=  8.67062D-02    |proj g|=  6.39718D-03

At iterate    8    f=  5.42668D-02    |proj g|=  3.55085D-03

At iterate    9    f=  2.17283D-02    |proj g|=  3.48746D-03

At iterate   10    f=  1.54659D-02    |proj g|=  3.43064D-03

At iterate   11    f=  1.22592D-02    |proj g|=  1.60071D-03

At iterate   12    f=  9.70373D-03    |proj g|=  8.02420D-04

At iterate   13    f=  7.21303D-03    |proj g|=  4.51048D-04

At iterate   14    f=  5.00244D-03    |proj g|=  6.45800D-04

At iterate   15    f=  3.21148D-03    |proj g|=  5.19249D-04

At iterate   16    f=  2.67258D-03    |proj g|=  3.60235D-04

At iterate   17    f=  1.85282D-03    |proj g|=  1.78507D-04

At iterate   18    f=  1.41804D-03    |proj g|=  2.01788D-04

At iterate   19    f=  1.01317D-03    |proj g|=  9.10477D-05

At iterate   20    f=  8.69403D-04    |proj g|=  6.33513D-05

At iterate   21    f=  6.38909D-04    |proj g|=  9.42186D-05

At iterate   22    f=  4.27697D-04    |proj g|=  5.96447D-05

At iterate   23    f=  3.46731D-04    |proj g|=  3.25850D-05

At iterate   24    f=  2.73893D-04    |proj g|=  2.01525D-05
```

```
At iterate   25    f=  2.09198D-04    |proj g|=  2.07993D-05

At iterate   26    f=  1.63236D-04    |proj g|=  4.77105D-05

At iterate   27    f=  1.15651D-04    |proj g|=  1.31001D-05

At iterate   28    f=  9.89894D-05    |proj g|=  1.00973D-05

At iterate   29    f=  7.66305D-05    |proj g|=  6.20369D-06

           * * *

Tit   = total number of iterations
Tnf   = total number of function evaluations
Tnint = total number of segments explored during Cauchy searches
Skip  = number of BFGS updates skipped
Nact  = number of active bounds at final generalized Cauchy point
Projg = norm of the final projected gradient
F     = final function value

           * * *

   N    Tit     Tnf  Tnint  Skip  Nact     Projg        F
 7840     29     30      1     0     0   6.204D-06   7.663D-05
  F =   7.6630518516421873E-005

CONVERGENCE: NORM_OF_PROJECTED_GRADIENT_<=_PGTOL
Training accuracy 1, test accuracy 0.815
10
(784, 938)
(938,)
Training classifier on 938 points...
RUNNING THE L-BFGS-B CODE

           * * *

Machine precision = 2.220D-16
 N =         7840     M =           10

At X0         0 variables are exactly at the bounds

At iterate    0    f=  8.84480D-01    |proj g|=  8.93479D-03

At iterate    1    f=  7.71158D-01    |proj g|=  7.56693D-03

At iterate    2    f=  6.27666D-01    |proj g|=  3.31254D-02

At iterate    3    f=  4.49369D-01    |proj g|=  8.78342D-03

At iterate    4    f=  3.90666D-01    |proj g|=  7.65992D-03

At iterate    5    f=  3.08815D-01    |proj g|=  7.67527D-03

At iterate    6    f=  2.41265D-01    |proj g|=  5.74354D-03

At iterate    7    f=  1.72192D-01    |proj g|=  7.99543D-03
```

```
At iterate    8    f=  1.34540D-01    |proj g|=  8.93848D-03

At iterate    9    f=  1.07195D-01    |proj g|=  4.18304D-03

At iterate   10    f=  8.44820D-02    |proj g|=  4.15464D-03

At iterate   11    f=  6.15295D-02    |proj g|=  4.61061D-03

At iterate   12    f=  4.64252D-02    |proj g|=  4.61068D-03

At iterate   13    f=  3.62150D-02    |proj g|=  2.33648D-03

At iterate   14    f=  2.40760D-02    |proj g|=  2.31600D-03

At iterate   15    f=  1.75732D-02    |proj g|=  2.31101D-03

At iterate   16    f=  1.11189D-02    |proj g|=  1.69135D-03

At iterate   17    f=  8.16901D-03    |proj g|=  6.78090D-04

At iterate   18    f=  6.81862D-03    |proj g|=  5.85428D-04

At iterate   19    f=  4.56149D-03    |proj g|=  3.36868D-04

At iterate   20    f=  4.02722D-03    |proj g|=  9.71354D-04

At iterate   21    f=  2.70893D-03    |proj g|=  2.43174D-04

At iterate   22    f=  2.44663D-03    |proj g|=  1.70029D-04

At iterate   23    f=  1.96685D-03    |proj g|=  9.22757D-05

At iterate   24    f=  1.65484D-03    |proj g|=  7.45295D-05

At iterate   25    f=  1.42322D-03    |proj g|=  2.71585D-04

At iterate   26    f=  1.12502D-03    |proj g|=  8.12578D-05

 This problem is unconstrained.
 This problem is unconstrained.
At iterate   27    f=  1.00986D-03    |proj g|=  5.33571D-05

At iterate   28    f=  7.89979D-04    |proj g|=  4.39522D-05

At iterate   29    f=  6.62478D-04    |proj g|=  9.43964D-05

At iterate   30    f=  5.51547D-04    |proj g|=  3.58814D-05

At iterate   31    f=  4.96505D-04    |proj g|=  2.79849D-05

At iterate   32    f=  4.11702D-04    |proj g|=  4.14739D-05

At iterate   33    f=  3.40918D-04    |proj g|=  1.96051D-05

At iterate   34    f=  3.01603D-04    |proj g|=  1.82466D-05
```

```
At iterate   35    f=  2.20033D-04    |proj g|=  2.38978D-05

At iterate   36    f=  1.77027D-04    |proj g|=  3.42573D-05

At iterate   37    f=  1.25182D-04    |proj g|=  1.19606D-05

At iterate   38    f=  1.10743D-04    |proj g|=  7.18754D-06

           * * *

Tit   = total number of iterations
Tnf   = total number of function evaluations
Tnint = total number of segments explored during Cauchy searches
Skip  = number of BFGS updates skipped
Nact  = number of active bounds at final generalized Cauchy point
Projg = norm of the final projected gradient
F     = final function value

           * * *

   N    Tit     Tnf  Tnint  Skip  Nact     Projg        F
 7840     38     39      1     0     0   7.188D-06   1.107D-04
  F =   1.1074254986834391E-004

CONVERGENCE: NORM_OF_PROJECTED_GRADIENT_<=_PGTOL
Training accuracy 1, test accuracy 0.843
11
(784, 1875)
(1875,)
Training classifier on 1875 points...
RUNNING THE L-BFGS-B CODE

           * * *

Machine precision = 2.220D-16
 N =         7840     M =           10

At X0         0 variables are exactly at the bounds

At iterate    0    f=  7.49856D-01    |proj g|=  8.60561D-03

At iterate    1    f=  6.69578D-01    |proj g|=  4.51101D-03

At iterate    2    f=  6.24994D-01    |proj g|=  4.71418D-03

At iterate    3    f=  5.22512D-01    |proj g|=  1.02553D-02

At iterate    4    f=  3.66677D-01    |proj g|=  9.95611D-03

At iterate    5    f=  2.86702D-01    |proj g|=  6.44615D-03

At iterate    6    f=  2.45393D-01    |proj g|=  4.53741D-03

At iterate    7    f=  2.12401D-01    |proj g|=  3.55071D-03

At iterate    8    f=  1.82405D-01    |proj g|=  4.93477D-03
```

```
At iterate    9    f=  1.59185D-01    |proj g|=  6.61555D-03

At iterate   10    f=  1.32797D-01    |proj g|=  2.26904D-03

At iterate   11    f=  1.16348D-01    |proj g|=  2.70913D-03

At iterate   12    f=  9.78736D-02    |proj g|=  2.80105D-03

At iterate   13    f=  6.93263D-02    |proj g|=  4.06377D-03

At iterate   14    f=  6.52793D-02    |proj g|=  7.17648D-03

At iterate   15    f=  5.10672D-02    |proj g|=  2.04248D-03

At iterate   16    f=  4.64100D-02    |proj g|=  1.39707D-03

At iterate   17    f=  3.69887D-02    |proj g|=  1.79030D-03

At iterate   18    f=  2.82967D-02    |proj g|=  2.02283D-03

At iterate   19    f=  2.35292D-02    |proj g|=  3.71408D-03

At iterate   20    f=  1.82503D-02    |proj g|=  1.00154D-03

At iterate   21    f=  1.67618D-02    |proj g|=  7.49137D-04

At iterate   22    f=  1.38592D-02    |proj g|=  7.02597D-04

At iterate   23    f=  1.26091D-02    |proj g|=  2.27141D-03

At iterate   24    f=  1.05073D-02    |proj g|=  6.13236D-04

At iterate   25    f=  9.96809D-03    |proj g|=  3.33209D-04

At iterate   26    f=  9.03069D-03    |proj g|=  5.26500D-04

At iterate   27    f=  7.87592D-03    |proj g|=  5.07453D-04

At iterate   28    f=  6.15224D-03    |proj g|=  4.20965D-04

At iterate   29    f=  5.41145D-03    |proj g|=  4.30184D-04

At iterate   30    f=  4.82510D-03    |proj g|=  3.23144D-04

At iterate   31    f=  4.47260D-03    |proj g|=  1.99739D-04

At iterate   32    f=  4.08747D-03    |proj g|=  1.62035D-04

At iterate   33    f=  3.77663D-03    |proj g|=  4.16073D-04

At iterate   34    f=  3.42541D-03    |proj g|=  1.84585D-04

At iterate   35    f=  3.14783D-03    |proj g|=  1.59161D-04

At iterate   36    f=  2.84816D-03    |proj g|=  1.32369D-04

At iterate   37    f=  2.50468D-03    |proj g|=  1.36252D-04
```

```
At iterate   38    f=  2.31710D-03    |proj g|=  2.15009D-04

At iterate   39    f=  2.02696D-03    |proj g|=  1.13197D-04

At iterate   40    f=  1.84136D-03    |proj g|=  6.68728D-05

At iterate   41    f=  1.65086D-03    |proj g|=  9.43702D-05

At iterate   42    f=  1.48291D-03    |proj g|=  1.38946D-04

At iterate   43    f=  1.33233D-03    |proj g|=  1.09251D-04

At iterate   44    f=  1.23398D-03    |proj g|=  8.04083D-05

At iterate   45    f=  1.05300D-03    |proj g|=  7.35885D-05

At iterate   46    f=  1.02238D-03    |proj g|=  1.59613D-04

At iterate   47    f=  8.75795D-04    |proj g|=  5.47479D-05

At iterate   48    f=  8.26373D-04    |proj g|=  3.67719D-05

At iterate   49    f=  7.37521D-04    |proj g|=  2.82618D-05

At iterate   50    f=  6.41171D-04    |proj g|=  2.90569D-05

At iterate   51    f=  6.02088D-04    |proj g|=  7.27614D-05

At iterate   52    f=  5.16839D-04    |proj g|=  3.33091D-05

At iterate   53    f=  4.59114D-04    |proj g|=  2.28329D-05

At iterate   54    f=  3.78973D-04    |proj g|=  2.94155D-05

At iterate   55    f=  3.34606D-04    |proj g|=  5.32289D-05

At iterate   56    f=  2.90366D-04    |proj g|=  2.94426D-05

At iterate   57    f=  2.65812D-04    |proj g|=  2.30716D-05

At iterate   58    f=  2.27002D-04    |proj g|=  1.20918D-05

At iterate   59    f=  1.95940D-04    |proj g|=  1.26247D-05

At iterate   60    f=  1.82004D-04    |proj g|=  2.29159D-05

At iterate   61    f=  1.54376D-04    |proj g|=  1.41092D-05

At iterate   62    f=  1.27110D-04    |proj g|=  8.60086D-06

           * * *

Tit   = total number of iterations
Tnf   = total number of function evaluations
Tnint = total number of segments explored during Cauchy searches
Skip  = number of BFGS updates skipped
```

```
Nact  = number of active bounds at final generalized Cauchy point
Projg = norm of the final projected gradient
F     = final function value

           * * *

   N    Tit     Tnf  Tnint  Skip  Nact     Projg        F
 7840     62     68      1     0     0   8.601D-06   1.271D-04
  F =   1.2711015248139103E-004

CONVERGENCE: NORM_OF_PROJECTED_GRADIENT_<=_PGTOL
Training accuracy 1, test accuracy 0.8587
12
(784, 3750)
(3750,)
Training classifier on 3750 points...
RUNNING THE L-BFGS-B CODE

           * * *

Machine precision = 2.220D-16
 N =         7840     M =           10

At X0         0 variables are exactly at the bounds

At iterate    0    f=  9.40553D-01    |proj g|=  7.73067D-03

At iterate    1    f=  9.00078D-01    |proj g|=  5.58015D-03

At iterate    2    f=  8.62015D-01    |proj g|=  5.83545D-03

At iterate    3    f=  7.76911D-01    |proj g|=  1.23306D-02

At iterate    4    f=  7.10178D-01    |proj g|=  1.45479D-02

At iterate    5    f=  6.34725D-01    |proj g|=  3.04730D-03

At iterate    6    f=  6.15266D-01    |proj g|=  3.53301D-03

At iterate    7    f=  5.65334D-01    |proj g|=  4.04249D-03

At iterate    8    f=  5.05852D-01    |proj g|=  7.66781D-03

At iterate    9    f=  4.76974D-01    |proj g|=  1.01809D-02

At iterate   10    f=  4.44714D-01    |proj g|=  2.82126D-03

At iterate   11    f=  4.31571D-01    |proj g|=  3.23547D-03

 This problem is unconstrained.
At iterate   12    f=  3.89510D-01    |proj g|=  5.17708D-03

At iterate   13    f=  3.57444D-01    |proj g|=  6.84976D-03

At iterate   14    f=  3.25065D-01    |proj g|=  3.69818D-03

At iterate   15    f=  3.02594D-01    |proj g|=  4.01744D-03
```

```
At iterate   16    f=  2.78310D-01    |proj g|=  4.18497D-03

At iterate   17    f=  2.49713D-01    |proj g|=  4.31799D-03

At iterate   18    f=  2.36354D-01    |proj g|=  4.66646D-03

At iterate   19    f=  2.15773D-01    |proj g|=  2.61329D-03

At iterate   20    f=  1.95016D-01    |proj g|=  3.15992D-03

At iterate   21    f=  1.80411D-01    |proj g|=  3.21403D-03

At iterate   22    f=  1.67947D-01    |proj g|=  2.81444D-03

At iterate   23    f=  1.56866D-01    |proj g|=  2.02523D-03

At iterate   24    f=  1.36116D-01    |proj g|=  3.32939D-03

At iterate   25    f=  1.29503D-01    |proj g|=  4.50865D-03

At iterate   26    f=  1.20444D-01    |proj g|=  3.20016D-03

At iterate   27    f=  1.06941D-01    |proj g|=  2.27347D-03

At iterate   28    f=  9.62226D-02    |proj g|=  3.15416D-03

At iterate   29    f=  8.88931D-02    |proj g|=  2.18046D-03

At iterate   30    f=  8.41117D-02    |proj g|=  1.47195D-03

At iterate   31    f=  7.80335D-02    |proj g|=  1.66764D-03

At iterate   32    f=  7.24167D-02    |proj g|=  1.44177D-03

At iterate   33    f=  6.33569D-02    |proj g|=  2.07294D-03

At iterate   34    f=  5.96251D-02    |proj g|=  2.32808D-03

At iterate   35    f=  5.59449D-02    |proj g|=  1.46173D-03

At iterate   36    f=  5.23169D-02    |proj g|=  9.15679D-04

At iterate   37    f=  4.77125D-02    |proj g|=  1.11418D-03

At iterate   38    f=  4.38251D-02    |proj g|=  2.09754D-03

At iterate   39    f=  3.99264D-02    |proj g|=  1.01305D-03

At iterate   40    f=  3.74874D-02    |proj g|=  9.94792D-04

At iterate   41    f=  3.56264D-02    |proj g|=  2.31987D-03

At iterate   42    f=  3.35235D-02    |proj g|=  1.09829D-03

At iterate   43    f=  3.19005D-02    |proj g|=  9.72283D-04
```

```
At iterate   44    f=  2.97588D-02    |proj g|=  1.10085D-03

At iterate   45    f=  2.76712D-02    |proj g|=  9.50414D-04

At iterate   46    f=  2.55343D-02    |proj g|=  1.23272D-03

At iterate   47    f=  2.41292D-02    |proj g|=  7.03286D-04

At iterate   48    f=  2.28693D-02    |proj g|=  7.11947D-04

At iterate   49    f=  2.14107D-02    |proj g|=  7.58582D-04

At iterate   50    f=  1.98616D-02    |proj g|=  1.74390D-03

At iterate   51    f=  1.81066D-02    |proj g|=  7.65492D-04

At iterate   52    f=  1.71511D-02    |proj g|=  5.52539D-04

At iterate   53    f=  1.64156D-02    |proj g|=  6.20040D-04

At iterate   54    f=  1.54907D-02    |proj g|=  9.52843D-04

At iterate   55    f=  1.46254D-02    |proj g|=  1.12861D-03

At iterate   56    f=  1.39334D-02    |proj g|=  5.44882D-04

At iterate   57    f=  1.32342D-02    |proj g|=  6.47864D-04

At iterate   58    f=  1.26464D-02    |proj g|=  7.47131D-04

At iterate   59    f=  1.19691D-02    |proj g|=  1.20124D-03

At iterate   60    f=  1.10678D-02    |proj g|=  6.15288D-04

At iterate   61    f=  1.08615D-02    |proj g|=  4.06851D-04

At iterate   62    f=  1.04201D-02    |proj g|=  4.37805D-04

At iterate   63    f=  1.00411D-02    |proj g|=  5.27847D-04

At iterate   64    f=  9.65221D-03    |proj g|=  8.32561D-04

At iterate   65    f=  9.10737D-03    |proj g|=  4.15459D-04

At iterate   66    f=  8.88595D-03    |proj g|=  2.32773D-04

At iterate   67    f=  8.60583D-03    |proj g|=  3.73829D-04

At iterate   68    f=  8.31482D-03    |proj g|=  3.87794D-04

At iterate   69    f=  8.09437D-03    |proj g|=  8.22681D-04

At iterate   70    f=  7.69455D-03    |proj g|=  4.72874D-04

At iterate   71    f=  7.37530D-03    |proj g|=  2.60633D-04

At iterate   72    f=  7.11408D-03    |proj g|=  3.02090D-04
```

```
At iterate   73    f=  6.84685D-03    |proj g|=  3.62241D-04

At iterate   74    f=  6.41604D-03    |proj g|=  3.52496D-04

At iterate   75    f=  6.27579D-03    |proj g|=  3.99980D-04

At iterate   76    f=  5.92450D-03    |proj g|=  2.28075D-04

At iterate   77    f=  5.66066D-03    |proj g|=  1.62066D-04

At iterate   78    f=  5.40271D-03    |proj g|=  2.71799D-04

At iterate   79    f=  5.23306D-03    |proj g|=  4.15157D-04

At iterate   80    f=  4.98272D-03    |proj g|=  2.76280D-04

At iterate   81    f=  4.77937D-03    |proj g|=  1.21352D-04

At iterate   82    f=  4.61243D-03    |proj g|=  1.64868D-04

At iterate   83    f=  4.43319D-03    |proj g|=  4.56507D-04

At iterate   84    f=  4.22197D-03    |proj g|=  2.99197D-04

At iterate   85    f=  4.02896D-03    |proj g|=  1.26440D-04

At iterate   86    f=  3.89497D-03    |proj g|=  1.35301D-04

At iterate   87    f=  3.73851D-03    |proj g|=  1.64718D-04

At iterate   88    f=  3.46827D-03    |proj g|=  2.14654D-04

At iterate   89    f=  3.32821D-03    |proj g|=  1.86982D-04

At iterate   90    f=  3.17066D-03    |proj g|=  8.74024D-05

At iterate   91    f=  3.05487D-03    |proj g|=  8.22669D-05

At iterate   92    f=  2.90583D-03    |proj g|=  1.05487D-04

At iterate   93    f=  2.76612D-03    |proj g|=  1.86473D-04

At iterate   94    f=  2.59993D-03    |proj g|=  1.13712D-04

At iterate   95    f=  2.52536D-03    |proj g|=  9.05634D-05

At iterate   96    f=  2.37538D-03    |proj g|=  8.05215D-05

At iterate   97    f=  2.36399D-03    |proj g|=  3.30454D-04

At iterate   98    f=  2.23910D-03    |proj g|=  1.29804D-04

At iterate   99    f=  2.15701D-03    |proj g|=  6.78275D-05

At iterate  100    f=  2.03617D-03    |proj g|=  8.76400D-05
```

```
At iterate  101    f=  1.94537D-03    |proj g|=  8.43844D-05

At iterate  102    f=  1.84434D-03    |proj g|=  1.61420D-04

At iterate  103    f=  1.69406D-03    |proj g|=  7.49057D-05

At iterate  104    f=  1.62070D-03    |proj g|=  5.49986D-05

At iterate  105    f=  1.53586D-03    |proj g|=  6.16895D-05

At iterate  106    f=  1.44020D-03    |proj g|=  6.04633D-05

At iterate  107    f=  1.36856D-03    |proj g|=  8.29711D-05

At iterate  108    f=  1.29353D-03    |proj g|=  5.11955D-05

At iterate  109    f=  1.24047D-03    |proj g|=  4.66355D-05

At iterate  110    f=  1.16785D-03    |proj g|=  3.68586D-05

At iterate  111    f=  1.13049D-03    |proj g|=  1.01197D-04

At iterate  112    f=  1.06015D-03    |proj g|=  6.34379D-05

At iterate  113    f=  1.00226D-03    |proj g|=  4.21375D-05

At iterate  114    f=  9.37602D-04    |proj g|=  4.26068D-05

At iterate  115    f=  8.64215D-04    |proj g|=  3.80259D-05

At iterate  116    f=  8.26045D-04    |proj g|=  7.29593D-05

At iterate  117    f=  7.74004D-04    |proj g|=  4.65708D-05

At iterate  118    f=  7.20086D-04    |proj g|=  2.31209D-05

At iterate  119    f=  6.57480D-04    |proj g|=  2.09063D-05

At iterate  120    f=  5.88799D-04    |proj g|=  2.40354D-05

At iterate  121    f=  5.47279D-04    |proj g|=  4.14995D-05

At iterate  122    f=  4.97162D-04    |proj g|=  2.80090D-05

At iterate  123    f=  4.70328D-04    |proj g|=  1.57858D-05

At iterate  124    f=  4.30656D-04    |proj g|=  1.64222D-05

At iterate  125    f=  3.88954D-04    |proj g|=  2.07534D-05

At iterate  126    f=  3.47944D-04    |proj g|=  2.25858D-05

At iterate  127    f=  3.25601D-04    |proj g|=  3.00244D-05

At iterate  128    f=  3.05350D-04    |proj g|=  1.33425D-05

At iterate  129    f=  2.84904D-04    |proj g|=  1.64349D-05
```

```
At iterate  130    f=  2.71924D-04    |proj g|=  2.46872D-05

At iterate  131    f=  2.53861D-04    |proj g|=  1.54161D-05

At iterate  132    f=  2.25438D-04    |proj g|=  9.67171D-06

           * * *

Tit   = total number of iterations
Tnf   = total number of function evaluations
Tnint = total number of segments explored during Cauchy searches
Skip  = number of BFGS updates skipped
Nact  = number of active bounds at final generalized Cauchy point
Projg = norm of the final projected gradient
F     = final function value

           * * *

   N    Tit     Tnf  Tnint  Skip  Nact     Projg        F
 7840    132    142      1     0     0   9.672D-06   2.254D-04
  F =   2.2543823489900807E-004

CONVERGENCE: NORM_OF_PROJECTED_GRADIENT_<=_PGTOL
Training accuracy 1, test accuracy 0.8484
13
(784, 7500)
(7500,)
Training classifier on 7500 points...
RUNNING THE L-BFGS-B CODE

           * * *

Machine precision = 2.220D-16
 N =         7840     M =           10

At X0         0 variables are exactly at the bounds

At iterate    0    f=  1.16457D+00    |proj g|=  4.65959D-03

At iterate    1    f=  1.13321D+00    |proj g|=  4.61551D-03

At iterate    2    f=  1.10984D+00    |proj g|=  3.36109D-03

At iterate    3    f=  1.03230D+00    |proj g|=  6.94440D-03

At iterate    4    f=  9.70585D-01    |proj g|=  4.64433D-03

At iterate    5    f=  9.01068D-01    |proj g|=  3.55051D-03

At iterate    6    f=  8.71198D-01    |proj g|=  3.31786D-03

At iterate    7    f=  8.13647D-01    |proj g|=  3.69343D-03

At iterate    8    f=  7.81972D-01    |proj g|=  4.75735D-03
 This problem is unconstrained.
At iterate    9    f=  7.46845D-01    |proj g|=  3.15519D-03
```

```
At iterate   10    f=  7.21480D-01    |proj g|=  2.92369D-03

At iterate   11    f=  6.82932D-01    |proj g|=  3.13492D-03

At iterate   12    f=  6.47826D-01    |proj g|=  5.00545D-03

At iterate   13    f=  6.11443D-01    |proj g|=  3.19777D-03

At iterate   14    f=  5.80691D-01    |proj g|=  2.51786D-03

At iterate   15    f=  5.60492D-01    |proj g|=  5.73220D-03

At iterate   16    f=  5.39935D-01    |proj g|=  2.92506D-03

At iterate   17    f=  5.22509D-01    |proj g|=  2.64282D-03

At iterate   18    f=  5.02054D-01    |proj g|=  2.79272D-03

At iterate   19    f=  4.77567D-01    |proj g|=  2.36924D-03

At iterate   20    f=  4.62709D-01    |proj g|=  4.24229D-03

At iterate   21    f=  4.45622D-01    |proj g|=  1.95881D-03

At iterate   22    f=  4.34205D-01    |proj g|=  2.12240D-03

At iterate   23    f=  4.18148D-01    |proj g|=  4.02228D-03

At iterate   24    f=  4.01153D-01    |proj g|=  3.07802D-03

At iterate   25    f=  3.82683D-01    |proj g|=  2.31503D-03

At iterate   26    f=  3.71988D-01    |proj g|=  3.16377D-03

At iterate   27    f=  3.61540D-01    |proj g|=  2.09237D-03

At iterate   28    f=  3.47844D-01    |proj g|=  2.65784D-03

At iterate   29    f=  3.37172D-01    |proj g|=  3.77872D-03

At iterate   30    f=  3.26652D-01    |proj g|=  2.73602D-03

At iterate   31    f=  3.19864D-01    |proj g|=  1.57756D-03

At iterate   32    f=  3.10321D-01    |proj g|=  2.13840D-03

At iterate   33    f=  3.01540D-01    |proj g|=  2.49179D-03

At iterate   34    f=  2.82916D-01    |proj g|=  2.02882D-03

At iterate   35    f=  2.74714D-01    |proj g|=  2.47906D-03

At iterate   36    f=  2.64386D-01    |proj g|=  1.33726D-03

At iterate   37    f=  2.57687D-01    |proj g|=  1.96992D-03
```

```
At iterate   38    f=  2.52854D-01    |proj g|=  3.50682D-03

At iterate   39    f=  2.47057D-01    |proj g|=  1.72313D-03

At iterate   40    f=  2.37665D-01    |proj g|=  1.95049D-03

At iterate   41    f=  2.31147D-01    |proj g|=  2.40348D-03

At iterate   42    f=  2.22174D-01    |proj g|=  4.03442D-03

At iterate   43    f=  2.15337D-01    |proj g|=  2.86854D-03

At iterate   44    f=  2.10126D-01    |proj g|=  1.72500D-03

At iterate   45    f=  2.04858D-01    |proj g|=  1.85514D-03

At iterate   46    f=  1.98021D-01    |proj g|=  1.79008D-03

At iterate   47    f=  1.96135D-01    |proj g|=  4.25348D-03

At iterate   48    f=  1.87342D-01    |proj g|=  1.37807D-03

At iterate   49    f=  1.83817D-01    |proj g|=  1.68156D-03

At iterate   50    f=  1.77810D-01    |proj g|=  1.94504D-03

At iterate   51    f=  1.70185D-01    |proj g|=  1.70216D-03

At iterate   52    f=  1.67127D-01    |proj g|=  3.02795D-03

At iterate   53    f=  1.61871D-01    |proj g|=  1.21838D-03

At iterate   54    f=  1.58826D-01    |proj g|=  9.81624D-04

At iterate   55    f=  1.54842D-01    |proj g|=  2.92171D-03

At iterate   56    f=  1.51411D-01    |proj g|=  1.37293D-03

At iterate   57    f=  1.48889D-01    |proj g|=  1.12354D-03

At iterate   58    f=  1.45460D-01    |proj g|=  1.27149D-03

At iterate   59    f=  1.41830D-01    |proj g|=  1.71269D-03

At iterate   60    f=  1.38062D-01    |proj g|=  1.31729D-03

At iterate   61    f=  1.33769D-01    |proj g|=  2.62148D-03

At iterate   62    f=  1.30080D-01    |proj g|=  1.04017D-03

At iterate   63    f=  1.28188D-01    |proj g|=  8.68220D-04

At iterate   64    f=  1.25173D-01    |proj g|=  1.37943D-03

At iterate   65    f=  1.22146D-01    |proj g|=  2.43427D-03

At iterate   66    f=  1.18359D-01    |proj g|=  1.47045D-03
```

```
At iterate   67    f=  1.14788D-01    |proj g|=  1.15148D-03

At iterate   68    f=  1.13206D-01    |proj g|=  2.66580D-03

At iterate   69    f=  1.11392D-01    |proj g|=  1.40813D-03

At iterate   70    f=  1.09034D-01    |proj g|=  8.92230D-04

At iterate   71    f=  1.06457D-01    |proj g|=  1.42492D-03

At iterate   72    f=  1.03254D-01    |proj g|=  1.61430D-03

At iterate   73    f=  1.01809D-01    |proj g|=  2.17667D-03

At iterate   74    f=  9.90091D-02    |proj g|=  1.28216D-03

At iterate   75    f=  9.70176D-02    |proj g|=  9.92306D-04

At iterate   76    f=  9.40789D-02    |proj g|=  1.36805D-03

At iterate   77    f=  9.30740D-02    |proj g|=  3.78615D-03

At iterate   78    f=  8.97782D-02    |proj g|=  9.21091D-04

At iterate   79    f=  8.84632D-02    |proj g|=  7.79268D-04

At iterate   80    f=  8.70427D-02    |proj g|=  9.51266D-04

At iterate   81    f=  8.43967D-02    |proj g|=  1.08690D-03

At iterate   82    f=  8.24675D-02    |proj g|=  2.18086D-03

At iterate   83    f=  7.94366D-02    |proj g|=  9.05467D-04

At iterate   84    f=  7.76886D-02    |proj g|=  7.39405D-04

At iterate   85    f=  7.51324D-02    |proj g|=  1.23776D-03

At iterate   86    f=  7.42898D-02    |proj g|=  2.90325D-03

At iterate   87    f=  7.19425D-02    |proj g|=  1.02816D-03

At iterate   88    f=  7.06532D-02    |proj g|=  5.93449D-04

At iterate   89    f=  6.92965D-02    |proj g|=  9.46620D-04

At iterate   90    f=  6.76406D-02    |proj g|=  1.07100D-03

At iterate   91    f=  6.61942D-02    |proj g|=  1.50420D-03

At iterate   92    f=  6.49536D-02    |proj g|=  6.11500D-04

At iterate   93    f=  6.34886D-02    |proj g|=  1.06541D-03

At iterate   94    f=  6.23319D-02    |proj g|=  1.16085D-03
```

```
At iterate   95    f=  6.15323D-02    |proj g|=  1.91321D-03

At iterate   96    f=  5.99704D-02    |proj g|=  8.30175D-04

At iterate   97    f=  5.91154D-02    |proj g|=  5.67747D-04

At iterate   98    f=  5.77790D-02    |proj g|=  9.30046D-04

At iterate   99    f=  5.62835D-02    |proj g|=  1.07378D-03

At iterate  100    f=  5.54171D-02    |proj g|=  1.86721D-03

At iterate  101    f=  5.38856D-02    |proj g|=  1.02894D-03

At iterate  102    f=  5.30417D-02    |proj g|=  4.60482D-04

At iterate  103    f=  5.20835D-02    |proj g|=  9.72304D-04

At iterate  104    f=  5.11469D-02    |proj g|=  1.10348D-03

At iterate  105    f=  4.99574D-02    |proj g|=  1.34915D-03

At iterate  106    f=  4.89436D-02    |proj g|=  6.87875D-04

At iterate  107    f=  4.75862D-02    |proj g|=  7.19861D-04

At iterate  108    f=  4.71901D-02    |proj g|=  1.26915D-03

At iterate  109    f=  4.63807D-02    |proj g|=  7.20668D-04

At iterate  110    f=  4.54058D-02    |proj g|=  7.14583D-04

At iterate  111    f=  4.46843D-02    |proj g|=  7.67105D-04

At iterate  112    f=  4.35293D-02    |proj g|=  8.41977D-04

At iterate  113    f=  4.27390D-02    |proj g|=  9.47802D-04

At iterate  114    f=  4.17802D-02    |proj g|=  4.30097D-04

At iterate  115    f=  4.10624D-02    |proj g|=  5.14815D-04

At iterate  116    f=  4.03672D-02    |proj g|=  1.01261D-03

At iterate  117    f=  3.95654D-02    |proj g|=  7.53791D-04

At iterate  118    f=  3.88450D-02    |proj g|=  1.02456D-03

At iterate  119    f=  3.81069D-02    |proj g|=  6.17506D-04

At iterate  120    f=  3.73867D-02    |proj g|=  5.91588D-04

At iterate  121    f=  3.66176D-02    |proj g|=  8.48182D-04

At iterate  122    f=  3.60438D-02    |proj g|=  5.92479D-04

At iterate  123    f=  3.55476D-02    |proj g|=  4.43486D-04
```

```
At iterate  124    f=  3.41136D-02    |proj g|=  6.66891D-04

At iterate  125    f=  3.36068D-02    |proj g|=  6.71918D-04

At iterate  126    f=  3.31476D-02    |proj g|=  4.70741D-04

At iterate  127    f=  3.24640D-02    |proj g|=  3.14318D-04

At iterate  128    f=  3.17283D-02    |proj g|=  6.54162D-04

At iterate  129    f=  3.11495D-02    |proj g|=  4.32190D-04

At iterate  130    f=  3.07115D-02    |proj g|=  3.13067D-04

At iterate  131    f=  3.01795D-02    |proj g|=  4.57285D-04

At iterate  132    f=  2.99492D-02    |proj g|=  1.55981D-03

At iterate  133    f=  2.92775D-02    |proj g|=  5.10092D-04

At iterate  134    f=  2.88770D-02    |proj g|=  4.32195D-04

At iterate  135    f=  2.85375D-02    |proj g|=  5.26305D-04

At iterate  136    f=  2.82350D-02    |proj g|=  1.23492D-03

At iterate  137    f=  2.76706D-02    |proj g|=  5.35468D-04

At iterate  138    f=  2.71232D-02    |proj g|=  4.77946D-04

At iterate  139    f=  2.66859D-02    |proj g|=  5.32420D-04

At iterate  140    f=  2.59917D-02    |proj g|=  4.60763D-04

At iterate  141    f=  2.56157D-02    |proj g|=  6.41140D-04

At iterate  142    f=  2.52592D-02    |proj g|=  3.44591D-04

At iterate  143    f=  2.49536D-02    |proj g|=  4.41023D-04

At iterate  144    f=  2.44468D-02    |proj g|=  4.74854D-04

At iterate  145    f=  2.37962D-02    |proj g|=  7.43643D-04

At iterate  146    f=  2.34650D-02    |proj g|=  6.31288D-04

At iterate  147    f=  2.31168D-02    |proj g|=  3.36827D-04

At iterate  148    f=  2.28369D-02    |proj g|=  3.53620D-04

At iterate  149    f=  2.24678D-02    |proj g|=  4.51787D-04

At iterate  150    f=  2.20520D-02    |proj g|=  7.11729D-04

At iterate  151    f=  2.16203D-02    |proj g|=  5.24725D-04
```

```
At iterate  152    f=  2.13662D-02    |proj g|=  3.09767D-04

At iterate  153    f=  2.10076D-02    |proj g|=  3.48272D-04

At iterate  154    f=  2.07798D-02    |proj g|=  3.60578D-04

At iterate  155    f=  2.04389D-02    |proj g|=  4.10881D-04

At iterate  156    f=  2.00619D-02    |proj g|=  2.61088D-04

At iterate  157    f=  1.97436D-02    |proj g|=  3.23685D-04

At iterate  158    f=  1.95033D-02    |proj g|=  6.29790D-04

At iterate  159    f=  1.92207D-02    |proj g|=  4.38597D-04

At iterate  160    f=  1.89795D-02    |proj g|=  2.63368D-04

At iterate  161    f=  1.86056D-02    |proj g|=  2.86409D-04

At iterate  162    f=  1.82630D-02    |proj g|=  3.69134D-04

At iterate  163    f=  1.81216D-02    |proj g|=  6.50987D-04

At iterate  164    f=  1.77832D-02    |proj g|=  2.65130D-04

At iterate  165    f=  1.76463D-02    |proj g|=  2.08286D-04

At iterate  166    f=  1.73538D-02    |proj g|=  2.74396D-04

At iterate  167    f=  1.71688D-02    |proj g|=  4.40029D-04

At iterate  168    f=  1.69758D-02    |proj g|=  2.48416D-04

At iterate  169    f=  1.67616D-02    |proj g|=  2.88516D-04

At iterate  170    f=  1.65401D-02    |proj g|=  2.84243D-04

At iterate  171    f=  1.63484D-02    |proj g|=  1.01637D-03

At iterate  172    f=  1.59919D-02    |proj g|=  2.78899D-04

At iterate  173    f=  1.58749D-02    |proj g|=  2.05327D-04

At iterate  174    f=  1.56630D-02    |proj g|=  3.10969D-04

At iterate  175    f=  1.53934D-02    |proj g|=  3.56803D-04

At iterate  176    f=  1.51823D-02    |proj g|=  4.05307D-04

At iterate  177    f=  1.49589D-02    |proj g|=  1.76900D-04

At iterate  178    f=  1.48291D-02    |proj g|=  1.89577D-04

At iterate  179    f=  1.46831D-02    |proj g|=  2.63172D-04

At iterate  180    f=  1.45705D-02    |proj g|=  6.09911D-04
```

```
At iterate  181    f=  1.43400D-02    |proj g|=  3.55390D-04

At iterate  182    f=  1.40853D-02    |proj g|=  2.25121D-04

At iterate  183    f=  1.38238D-02    |proj g|=  2.19999D-04

At iterate  184    f=  1.36170D-02    |proj g|=  4.75639D-04

At iterate  185    f=  1.34437D-02    |proj g|=  2.58326D-04

At iterate  186    f=  1.33066D-02    |proj g|=  1.75657D-04

At iterate  187    f=  1.31599D-02    |proj g|=  1.84505D-04

At iterate  188    f=  1.29962D-02    |proj g|=  1.78558D-04

At iterate  189    f=  1.28558D-02    |proj g|=  5.62964D-04

At iterate  190    f=  1.26356D-02    |proj g|=  1.91963D-04

At iterate  191    f=  1.25549D-02    |proj g|=  1.76471D-04

At iterate  192    f=  1.24140D-02    |proj g|=  1.85926D-04

At iterate  193    f=  1.22566D-02    |proj g|=  6.03537D-04

At iterate  194    f=  1.20513D-02    |proj g|=  2.60056D-04

At iterate  195    f=  1.19372D-02    |proj g|=  1.66117D-04

At iterate  196    f=  1.18241D-02    |proj g|=  2.15468D-04

At iterate  197    f=  1.16781D-02    |proj g|=  2.09790D-04

At iterate  198    f=  1.15866D-02    |proj g|=  3.65608D-04

At iterate  199    f=  1.14182D-02    |proj g|=  1.69023D-04

At iterate  200    f=  1.12917D-02    |proj g|=  1.33344D-04

At iterate  201    f=  1.11701D-02    |proj g|=  1.68352D-04

At iterate  202    f=  1.10109D-02    |proj g|=  1.91899D-04

At iterate  203    f=  1.09351D-02    |proj g|=  2.83322D-04

At iterate  204    f=  1.07900D-02    |proj g|=  1.50924D-04

At iterate  205    f=  1.06722D-02    |proj g|=  1.30327D-04

At iterate  206    f=  1.05282D-02    |proj g|=  3.11273D-04

At iterate  207    f=  1.04022D-02    |proj g|=  1.94850D-04

At iterate  208    f=  1.03104D-02    |proj g|=  1.53694D-04
```

```
At iterate  209    f=  1.01453D-02    |proj g|=  2.22013D-04

At iterate  210    f=  1.00376D-02    |proj g|=  1.80678D-04

At iterate  211    f=  9.91058D-03    |proj g|=  2.03291D-04

At iterate  212    f=  9.74007D-03    |proj g|=  1.44162D-04

At iterate  213    f=  9.50323D-03    |proj g|=  1.62234D-04

At iterate  214    f=  9.44252D-03    |proj g|=  5.50350D-04

At iterate  215    f=  9.25954D-03    |proj g|=  1.43843D-04

At iterate  216    f=  9.19628D-03    |proj g|=  1.32806D-04

At iterate  217    f=  9.10183D-03    |proj g|=  1.88758D-04

At iterate  218    f=  8.94629D-03    |proj g|=  1.73787D-04

At iterate  219    f=  8.65506D-03    |proj g|=  2.94209D-04

At iterate  220    f=  8.50490D-03    |proj g|=  2.29772D-04

At iterate  221    f=  8.39156D-03    |proj g|=  1.20477D-04

At iterate  222    f=  8.30062D-03    |proj g|=  1.34071D-04

At iterate  223    f=  8.21446D-03    |proj g|=  2.41180D-04

At iterate  224    f=  8.09684D-03    |proj g|=  1.63911D-04

At iterate  225    f=  7.92253D-03    |proj g|=  1.09409D-04

At iterate  226    f=  7.75975D-03    |proj g|=  1.27471D-04

At iterate  227    f=  7.69147D-03    |proj g|=  4.97708D-04

At iterate  228    f=  7.53556D-03    |proj g|=  1.38944D-04

At iterate  229    f=  7.47075D-03    |proj g|=  7.61433D-05

At iterate  230    f=  7.40528D-03    |proj g|=  1.22492D-04

At iterate  231    f=  7.30953D-03    |proj g|=  1.29424D-04

At iterate  232    f=  7.24702D-03    |proj g|=  2.13479D-04

At iterate  233    f=  7.12412D-03    |proj g|=  1.06607D-04

At iterate  234    f=  7.02264D-03    |proj g|=  9.82365D-05

At iterate  235    f=  6.87437D-03    |proj g|=  1.79277D-04

At iterate  236    f=  6.79295D-03    |proj g|=  4.53514D-04

At iterate  237    f=  6.67846D-03    |proj g|=  1.69233D-04
```

```
At iterate  238    f=  6.59263D-03    |proj g|=  1.28213D-04

At iterate  239    f=  6.52905D-03    |proj g|=  1.57652D-04

At iterate  240    f=  6.39535D-03    |proj g|=  1.60839D-04

At iterate  241    f=  6.31609D-03    |proj g|=  1.88128D-04

At iterate  242    f=  6.21586D-03    |proj g|=  1.04672D-04

At iterate  243    f=  6.14224D-03    |proj g|=  1.12947D-04

At iterate  244    f=  6.01975D-03    |proj g|=  1.42124D-04

At iterate  245    f=  5.89090D-03    |proj g|=  1.58049D-04

At iterate  246    f=  5.75290D-03    |proj g|=  1.59770D-04

At iterate  247    f=  5.68201D-03    |proj g|=  1.60742D-04

At iterate  248    f=  5.61750D-03    |proj g|=  9.99361D-05

At iterate  249    f=  5.56421D-03    |proj g|=  8.44218D-05

At iterate  250    f=  5.48868D-03    |proj g|=  1.66643D-04

At iterate  251    f=  5.36500D-03    |proj g|=  1.21235D-04

At iterate  252    f=  5.25891D-03    |proj g|=  1.50257D-04

At iterate  253    f=  5.18986D-03    |proj g|=  1.80827D-04

At iterate  254    f=  5.12746D-03    |proj g|=  9.07293D-05

At iterate  255    f=  5.08551D-03    |proj g|=  8.62783D-05

At iterate  256    f=  4.98545D-03    |proj g|=  1.08461D-04

At iterate  257    f=  4.84389D-03    |proj g|=  1.22832D-04

At iterate  258    f=  4.77011D-03    |proj g|=  1.77464D-04

At iterate  259    f=  4.62967D-03    |proj g|=  9.64807D-05

At iterate  260    f=  4.54957D-03    |proj g|=  8.01644D-05

At iterate  261    f=  4.46490D-03    |proj g|=  1.06268D-04

At iterate  262    f=  4.37960D-03    |proj g|=  1.06820D-04

At iterate  263    f=  4.30311D-03    |proj g|=  1.61070D-04

At iterate  264    f=  4.22171D-03    |proj g|=  9.62249D-05

At iterate  265    f=  4.16144D-03    |proj g|=  9.37629D-05
```

```
At iterate  266    f=  4.04060D-03    |proj g|=  1.06560D-04

At iterate  267    f=  3.98090D-03    |proj g|=  1.57511D-04

At iterate  268    f=  3.90754D-03    |proj g|=  8.61484D-05

At iterate  269    f=  3.84352D-03    |proj g|=  6.97204D-05

At iterate  270    f=  3.77139D-03    |proj g|=  1.04760D-04

At iterate  271    f=  3.64050D-03    |proj g|=  1.30237D-04

At iterate  272    f=  3.58471D-03    |proj g|=  1.29038D-04

At iterate  273    f=  3.45463D-03    |proj g|=  8.80180D-05

At iterate  274    f=  3.37027D-03    |proj g|=  6.25922D-05

At iterate  275    f=  3.29869D-03    |proj g|=  1.81364D-04

At iterate  276    f=  3.22405D-03    |proj g|=  9.04259D-05

At iterate  277    f=  3.17181D-03    |proj g|=  6.59372D-05

At iterate  278    f=  3.10538D-03    |proj g|=  7.88722D-05

At iterate  279    f=  3.01507D-03    |proj g|=  1.08758D-04

At iterate  280    f=  2.90759D-03    |proj g|=  9.06253D-05

At iterate  281    f=  2.87978D-03    |proj g|=  2.11650D-04

At iterate  282    f=  2.79494D-03    |proj g|=  7.25174D-05

At iterate  283    f=  2.76205D-03    |proj g|=  4.46239D-05

At iterate  284    f=  2.72176D-03    |proj g|=  6.07859D-05

At iterate  285    f=  2.65414D-03    |proj g|=  8.09735D-05

At iterate  286    f=  2.55564D-03    |proj g|=  1.63392D-04

At iterate  287    f=  2.45370D-03    |proj g|=  8.53465D-05

At iterate  288    f=  2.40877D-03    |proj g|=  5.08723D-05

At iterate  289    f=  2.35629D-03    |proj g|=  6.04218D-05

At iterate  290    f=  2.31610D-03    |proj g|=  9.31661D-05

At iterate  291    f=  2.23293D-03    |proj g|=  1.34546D-04

At iterate  292    f=  2.15866D-03    |proj g|=  1.20663D-04

At iterate  293    f=  2.10688D-03    |proj g|=  6.10626D-05

At iterate  294    f=  2.05713D-03    |proj g|=  6.27062D-05
```

```
At iterate  295    f=  2.02329D-03    |proj g|=  6.63904D-05

At iterate  296    f=  1.92506D-03    |proj g|=  9.18586D-05

At iterate  297    f=  1.91005D-03    |proj g|=  1.36380D-04

At iterate  298    f=  1.82187D-03    |proj g|=  6.19682D-05

At iterate  299    f=  1.79364D-03    |proj g|=  3.74634D-05

At iterate  300    f=  1.73266D-03    |proj g|=  6.11406D-05

At iterate  301    f=  1.66683D-03    |proj g|=  8.87748D-05

At iterate  302    f=  1.60407D-03    |proj g|=  5.19266D-05

At iterate  303    f=  1.56129D-03    |proj g|=  4.44725D-05

At iterate  304    f=  1.52435D-03    |proj g|=  9.31123D-05

At iterate  305    f=  1.47807D-03    |proj g|=  6.99613D-05

At iterate  306    f=  1.41586D-03    |proj g|=  4.73974D-05

At iterate  307    f=  1.34802D-03    |proj g|=  3.93887D-05

At iterate  308    f=  1.29481D-03    |proj g|=  5.10291D-05

At iterate  309    f=  1.24793D-03    |proj g|=  4.59993D-05

At iterate  310    f=  1.19041D-03    |proj g|=  3.59678D-05

At iterate  311    f=  1.12142D-03    |proj g|=  5.82749D-05

At iterate  312    f=  1.04706D-03    |proj g|=  3.22454D-05

At iterate  313    f=  1.01026D-03    |proj g|=  3.93619D-05

At iterate  314    f=  9.77136D-04    |proj g|=  4.05137D-05

At iterate  315    f=  9.44902D-04    |proj g|=  2.94535D-05

At iterate  316    f=  8.96421D-04    |proj g|=  3.15358D-05

At iterate  317    f=  8.51910D-04    |proj g|=  4.55218D-05

At iterate  318    f=  8.05259D-04    |proj g|=  4.56230D-05

At iterate  319    f=  7.69300D-04    |proj g|=  2.22640D-05

At iterate  320    f=  7.34074D-04    |proj g|=  2.36751D-05

At iterate  321    f=  6.99992D-04    |proj g|=  2.53709D-05

At iterate  322    f=  6.46949D-04    |proj g|=  5.37524D-05
```

```
At iterate  323    f=  6.13172D-04    |proj g|=  3.52870D-05

At iterate  324    f=  5.87103D-04    |proj g|=  1.89738D-05

At iterate  325    f=  5.69087D-04    |proj g|=  1.39531D-05

At iterate  326    f=  5.49547D-04    |proj g|=  1.74860D-05

At iterate  327    f=  5.04596D-04    |proj g|=  2.32514D-05

At iterate  328    f=  4.80261D-04    |proj g|=  3.41808D-05

At iterate  329    f=  4.40613D-04    |proj g|=  1.37781D-05

At iterate  330    f=  4.17833D-04    |proj g|=  2.06967D-05

At iterate  331    f=  3.96645D-04    |proj g|=  2.18267D-05

At iterate  332    f=  3.80462D-04    |proj g|=  1.42691D-05

At iterate  333    f=  3.54216D-04    |proj g|=  1.41476D-05

At iterate  334    f=  3.33414D-04    |proj g|=  1.49292D-05

At iterate  335    f=  2.93559D-04    |proj g|=  1.38274D-05

At iterate  336    f=  2.79840D-04    |proj g|=  2.58393D-05

At iterate  337    f=  2.49720D-04    |proj g|=  1.02051D-05

At iterate  338    f=  2.32089D-04    |proj g|=  5.98593D-06

           * * *

Tit   = total number of iterations
Tnf   = total number of function evaluations
Tnint = total number of segments explored during Cauchy searches
Skip  = number of BFGS updates skipped
Nact  = number of active bounds at final generalized Cauchy point
Projg = norm of the final projected gradient
F     = final function value

           * * *

   N    Tit     Tnf  Tnint  Skip  Nact     Projg        F
 7840    338    365      1     0     0   5.986D-06   2.321D-04
  F =   2.3208893943757228E-004

CONVERGENCE: NORM_OF_PROJECTED_GRADIENT_<=_PGTOL
Training accuracy 1, test accuracy 0.8476
14
(784, 15000)
(15000,)
Training classifier on 15000 points...
RUNNING THE L-BFGS-B CODE

           * * *
```

```
Machine precision = 2.220D-16
 N =         7840     M =           10

At X0         0 variables are exactly at the bounds

At iterate    0    f=  2.05619D+00    |proj g|=  4.11989D-03
 This problem is unconstrained.
At iterate    1    f=  2.01866D+00    |proj g|=  2.81672D-03

At iterate    2    f=  1.99219D+00    |proj g|=  3.24801D-03

At iterate    3    f=  1.95937D+00    |proj g|=  3.47759D-03

At iterate    4    f=  1.88740D+00    |proj g|=  4.92291D-03

At iterate    5    f=  1.83668D+00    |proj g|=  5.73673D-03

At iterate    6    f=  1.77952D+00    |proj g|=  4.63066D-03

At iterate    7    f=  1.74834D+00    |proj g|=  2.53268D-03

At iterate    8    f=  1.71008D+00    |proj g|=  2.59078D-03

At iterate    9    f=  1.65956D+00    |proj g|=  3.84256D-03

At iterate   10    f=  1.61442D+00    |proj g|=  5.23703D-03

At iterate   11    f=  1.58156D+00    |proj g|=  2.11239D-03

At iterate   12    f=  1.56756D+00    |proj g|=  2.09026D-03

At iterate   13    f=  1.54563D+00    |proj g|=  2.61417D-03

At iterate   14    f=  1.49919D+00    |proj g|=  2.73075D-03

At iterate   15    f=  1.47887D+00    |proj g|=  4.12187D-03

At iterate   16    f=  1.44397D+00    |proj g|=  3.05615D-03

At iterate   17    f=  1.41297D+00    |proj g|=  1.79164D-03

At iterate   18    f=  1.38883D+00    |proj g|=  3.22906D-03

At iterate   19    f=  1.35735D+00    |proj g|=  4.10748D-03

At iterate   20    f=  1.32636D+00    |proj g|=  3.11767D-03

At iterate   21    f=  1.30044D+00    |proj g|=  2.26199D-03

At iterate   22    f=  1.28023D+00    |proj g|=  2.67447D-03

At iterate   23    f=  1.25858D+00    |proj g|=  2.73972D-03

At iterate   24    f=  1.23675D+00    |proj g|=  2.13006D-03

At iterate   25    f=  1.21808D+00    |proj g|=  1.55648D-03
```

```
At iterate   26    f=  1.19340D+00    |proj g|=  1.88041D-03

At iterate   27    f=  1.16018D+00    |proj g|=  2.03959D-03

At iterate   28    f=  1.13765D+00    |proj g|=  4.25824D-03

At iterate   29    f=  1.11120D+00    |proj g|=  1.63883D-03

At iterate   30    f=  1.09453D+00    |proj g|=  1.86508D-03

At iterate   31    f=  1.07699D+00    |proj g|=  3.02117D-03

At iterate   32    f=  1.06326D+00    |proj g|=  3.99570D-03

At iterate   33    f=  1.04798D+00    |proj g|=  1.95186D-03

At iterate   34    f=  1.02685D+00    |proj g|=  2.52820D-03

At iterate   35    f=  1.01546D+00    |proj g|=  2.59100D-03

At iterate   36    f=  9.96127D-01    |proj g|=  2.74685D-03

At iterate   37    f=  9.78160D-01    |proj g|=  2.89686D-03

At iterate   38    f=  9.65673D-01    |proj g|=  2.48642D-03

At iterate   39    f=  9.45164D-01    |proj g|=  2.20707D-03

At iterate   40    f=  9.32065D-01    |proj g|=  3.02801D-03

At iterate   41    f=  9.18794D-01    |proj g|=  1.93982D-03

At iterate   42    f=  8.99284D-01    |proj g|=  2.25772D-03

At iterate   43    f=  8.88020D-01    |proj g|=  2.18006D-03

At iterate   44    f=  8.59101D-01    |proj g|=  1.83864D-03

At iterate   45    f=  8.54003D-01    |proj g|=  6.65621D-03

At iterate   46    f=  8.37940D-01    |proj g|=  2.60914D-03

At iterate   47    f=  8.29616D-01    |proj g|=  1.45759D-03

At iterate   48    f=  8.20018D-01    |proj g|=  2.57007D-03

At iterate   49    f=  8.06627D-01    |proj g|=  2.44150D-03

At iterate   50    f=  8.05106D-01    |proj g|=  7.77085D-03

At iterate   51    f=  7.84104D-01    |proj g|=  1.74783D-03

At iterate   52    f=  7.78099D-01    |proj g|=  1.70218D-03

At iterate   53    f=  7.69461D-01    |proj g|=  1.83696D-03
```

```
At iterate   54    f=  7.63270D-01    |proj g|=  3.90735D-03

At iterate   55    f=  7.51240D-01    |proj g|=  1.98250D-03

At iterate   56    f=  7.43504D-01    |proj g|=  1.41496D-03

At iterate   57    f=  7.34732D-01    |proj g|=  2.23332D-03

At iterate   58    f=  7.23340D-01    |proj g|=  2.00569D-03

At iterate   59    f=  7.17364D-01    |proj g|=  3.87427D-03

At iterate   60    f=  7.07768D-01    |proj g|=  1.38026D-03

At iterate   61    f=  6.99192D-01    |proj g|=  1.86793D-03

At iterate   62    f=  6.87376D-01    |proj g|=  2.65700D-03

At iterate   63    f=  6.74969D-01    |proj g|=  2.11240D-03

At iterate   64    f=  6.68759D-01    |proj g|=  3.04328D-03

At iterate   65    f=  6.59703D-01    |proj g|=  1.58358D-03

At iterate   66    f=  6.52139D-01    |proj g|=  1.90251D-03

At iterate   67    f=  6.39976D-01    |proj g|=  1.91104D-03

At iterate   68    f=  6.33326D-01    |proj g|=  2.85317D-03

At iterate   69    f=  6.21676D-01    |proj g|=  1.34301D-03

At iterate   70    f=  6.13504D-01    |proj g|=  1.41747D-03

At iterate   71    f=  6.06475D-01    |proj g|=  2.22321D-03

At iterate   72    f=  6.00611D-01    |proj g|=  3.00984D-03

At iterate   73    f=  5.94490D-01    |proj g|=  1.77045D-03

At iterate   74    f=  5.88264D-01    |proj g|=  1.37160D-03

At iterate   75    f=  5.84175D-01    |proj g|=  1.72815D-03

At iterate   76    f=  5.79600D-01    |proj g|=  3.26865D-03

At iterate   77    f=  5.73065D-01    |proj g|=  1.56504D-03

At iterate   78    f=  5.68333D-01    |proj g|=  1.25968D-03

At iterate   79    f=  5.61482D-01    |proj g|=  2.48914D-03

At iterate   80    f=  5.55542D-01    |proj g|=  1.57194D-03

At iterate   81    f=  5.50097D-01    |proj g|=  1.47728D-03

At iterate   82    f=  5.39679D-01    |proj g|=  1.42507D-03
```

```
At iterate   83    f=  5.29141D-01    |proj g|=  1.54231D-03

At iterate   84    f=  5.22978D-01    |proj g|=  2.92351D-03

At iterate   85    f=  5.13667D-01    |proj g|=  1.18480D-03

At iterate   86    f=  5.09554D-01    |proj g|=  1.06312D-03

At iterate   87    f=  5.02780D-01    |proj g|=  1.22944D-03

At iterate   88    f=  5.01015D-01    |proj g|=  3.06737D-03

At iterate   89    f=  4.94477D-01    |proj g|=  1.35859D-03

At iterate   90    f=  4.90910D-01    |proj g|=  1.38728D-03

At iterate   91    f=  4.85977D-01    |proj g|=  1.59904D-03

At iterate   92    f=  4.82366D-01    |proj g|=  2.60495D-03

At iterate   93    f=  4.76424D-01    |proj g|=  1.53770D-03

At iterate   94    f=  4.71066D-01    |proj g|=  1.00634D-03

At iterate   95    f=  4.66620D-01    |proj g|=  1.44069D-03

At iterate   96    f=  4.61167D-01    |proj g|=  1.73540D-03

At iterate   97    f=  4.54978D-01    |proj g|=  1.28757D-03

At iterate   98    f=  4.48736D-01    |proj g|=  1.51375D-03

At iterate   99    f=  4.45409D-01    |proj g|=  2.73442D-03

At iterate  100    f=  4.41427D-01    |proj g|=  1.26127D-03

At iterate  101    f=  4.37851D-01    |proj g|=  1.18595D-03

At iterate  102    f=  4.33980D-01    |proj g|=  1.34953D-03

At iterate  103    f=  4.28635D-01    |proj g|=  2.05686D-03

At iterate  104    f=  4.25528D-01    |proj g|=  2.84650D-03

At iterate  105    f=  4.21458D-01    |proj g|=  1.04023D-03

At iterate  106    f=  4.18604D-01    |proj g|=  1.19383D-03

At iterate  107    f=  4.15074D-01    |proj g|=  1.40287D-03

At iterate  108    f=  4.13611D-01    |proj g|=  4.16809D-03

At iterate  109    f=  4.06365D-01    |proj g|=  1.41111D-03

At iterate  110    f=  4.03258D-01    |proj g|=  1.50403D-03
```

```
At iterate  111    f=  3.99479D-01    |proj g|=  1.87140D-03

At iterate  112    f=  3.94504D-01    |proj g|=  2.12425D-03

At iterate  113    f=  3.91521D-01    |proj g|=  2.09706D-03

At iterate  114    f=  3.87640D-01    |proj g|=  1.20784D-03

At iterate  115    f=  3.84780D-01    |proj g|=  1.06994D-03

At iterate  116    f=  3.81832D-01    |proj g|=  1.37416D-03

At iterate  117    f=  3.80359D-01    |proj g|=  3.90905D-03

At iterate  118    f=  3.76346D-01    |proj g|=  1.20682D-03

At iterate  119    f=  3.73971D-01    |proj g|=  9.06023D-04

At iterate  120    f=  3.71318D-01    |proj g|=  1.28981D-03

At iterate  121    f=  3.66820D-01    |proj g|=  1.51704D-03

At iterate  122    f=  3.64796D-01    |proj g|=  3.30208D-03

At iterate  123    f=  3.59357D-01    |proj g|=  9.13957D-04

At iterate  124    f=  3.57458D-01    |proj g|=  1.03243D-03

At iterate  125    f=  3.53777D-01    |proj g|=  1.34341D-03

At iterate  126    f=  3.52299D-01    |proj g|=  2.80321D-03

At iterate  127    f=  3.47880D-01    |proj g|=  9.85921D-04

At iterate  128    f=  3.45551D-01    |proj g|=  8.81799D-04

At iterate  129    f=  3.43127D-01    |proj g|=  1.43107D-03

At iterate  130    f=  3.40570D-01    |proj g|=  1.54772D-03

At iterate  131    f=  3.37984D-01    |proj g|=  9.58413D-04

At iterate  132    f=  3.34486D-01    |proj g|=  1.32504D-03

At iterate  133    f=  3.32762D-01    |proj g|=  2.49475D-03

At iterate  134    f=  3.30913D-01    |proj g|=  1.40992D-03

At iterate  135    f=  3.28234D-01    |proj g|=  1.12574D-03

At iterate  136    f=  3.26416D-01    |proj g|=  1.46240D-03

At iterate  137    f=  3.22458D-01    |proj g|=  2.03360D-03

At iterate  138    f=  3.21767D-01    |proj g|=  2.96505D-03

At iterate  139    f=  3.17549D-01    |proj g|=  1.11033D-03
```

```
At iterate  140    f=  3.16066D-01    |proj g|=  8.69146D-04

At iterate  141    f=  3.13764D-01    |proj g|=  1.03930D-03

At iterate  142    f=  3.10039D-01    |proj g|=  9.92505D-04

At iterate  143    f=  3.08242D-01    |proj g|=  1.88551D-03

At iterate  144    f=  3.04631D-01    |proj g|=  1.05506D-03

At iterate  145    f=  3.02334D-01    |proj g|=  1.08601D-03

At iterate  146    f=  3.00378D-01    |proj g|=  1.97903D-03

At iterate  147    f=  2.98238D-01    |proj g|=  1.19809D-03

At iterate  148    f=  2.96772D-01    |proj g|=  1.10113D-03

At iterate  149    f=  2.93997D-01    |proj g|=  9.21491D-04

At iterate  150    f=  2.91309D-01    |proj g|=  1.71388D-03

At iterate  151    f=  2.88063D-01    |proj g|=  1.01294D-03

At iterate  152    f=  2.85736D-01    |proj g|=  8.70680D-04

At iterate  153    f=  2.83679D-01    |proj g|=  8.98080D-04

At iterate  154    f=  2.80595D-01    |proj g|=  1.13779D-03

At iterate  155    f=  2.77661D-01    |proj g|=  1.38746D-03

At iterate  156    f=  2.75307D-01    |proj g|=  1.04978D-03

At iterate  157    f=  2.73606D-01    |proj g|=  8.37441D-04

At iterate  158    f=  2.70531D-01    |proj g|=  8.80207D-04

At iterate  159    f=  2.68820D-01    |proj g|=  2.25884D-03

At iterate  160    f=  2.66108D-01    |proj g|=  1.01088D-03

At iterate  161    f=  2.64906D-01    |proj g|=  8.25666D-04

At iterate  162    f=  2.63493D-01    |proj g|=  9.56295D-04

At iterate  163    f=  2.60615D-01    |proj g|=  8.52981D-04

At iterate  164    f=  2.58726D-01    |proj g|=  2.06710D-03

At iterate  165    f=  2.56471D-01    |proj g|=  8.22170D-04

At iterate  166    f=  2.55590D-01    |proj g|=  7.97965D-04

At iterate  167    f=  2.53371D-01    |proj g|=  8.12999D-04
```

```
At iterate  168    f=  2.51201D-01    |proj g|=  9.97417D-04

At iterate  169    f=  2.49807D-01    |proj g|=  1.32480D-03

At iterate  170    f=  2.48253D-01    |proj g|=  7.19075D-04

At iterate  171    f=  2.47173D-01    |proj g|=  7.65968D-04

At iterate  172    f=  2.46174D-01    |proj g|=  8.70301D-04

At iterate  173    f=  2.43555D-01    |proj g|=  9.85477D-04

At iterate  174    f=  2.42613D-01    |proj g|=  2.13286D-03

At iterate  175    f=  2.40259D-01    |proj g|=  1.44053D-03

At iterate  176    f=  2.38196D-01    |proj g|=  8.21000D-04

At iterate  177    f=  2.36214D-01    |proj g|=  1.32643D-03

At iterate  178    f=  2.35009D-01    |proj g|=  1.33621D-03

At iterate  179    f=  2.33985D-01    |proj g|=  7.41406D-04

At iterate  180    f=  2.32664D-01    |proj g|=  9.44228D-04

At iterate  181    f=  2.31482D-01    |proj g|=  1.13527D-03

At iterate  182    f=  2.28602D-01    |proj g|=  1.53640D-03

At iterate  183    f=  2.27843D-01    |proj g|=  2.26848D-03

At iterate  184    f=  2.25478D-01    |proj g|=  8.38352D-04

At iterate  185    f=  2.24630D-01    |proj g|=  6.58511D-04

At iterate  186    f=  2.23315D-01    |proj g|=  9.00877D-04

At iterate  187    f=  2.21668D-01    |proj g|=  2.08491D-03

At iterate  188    f=  2.20027D-01    |proj g|=  1.14411D-03

At iterate  189    f=  2.19037D-01    |proj g|=  8.14825D-04

At iterate  190    f=  2.17926D-01    |proj g|=  7.82917D-04

At iterate  191    f=  2.16633D-01    |proj g|=  1.03709D-03

At iterate  192    f=  2.14746D-01    |proj g|=  9.92775D-04

At iterate  193    f=  2.13657D-01    |proj g|=  9.73395D-04

At iterate  194    f=  2.12820D-01    |proj g|=  6.33446D-04

At iterate  195    f=  2.11588D-01    |proj g|=  8.72719D-04

At iterate  196    f=  2.10534D-01    |proj g|=  1.09765D-03
```

```
At iterate  197    f=  2.08600D-01    |proj g|=  1.62185D-03

At iterate  198    f=  2.07309D-01    |proj g|=  1.17045D-03

At iterate  199    f=  2.06113D-01    |proj g|=  6.65070D-04

At iterate  200    f=  2.04784D-01    |proj g|=  1.13629D-03

At iterate  201    f=  2.04029D-01    |proj g|=  1.88546D-03

At iterate  202    f=  2.02971D-01    |proj g|=  1.02291D-03

At iterate  203    f=  2.01805D-01    |proj g|=  6.15306D-04

At iterate  204    f=  2.01151D-01    |proj g|=  7.80396D-04

At iterate  205    f=  1.99447D-01    |proj g|=  9.81997D-04

At iterate  206    f=  1.98089D-01    |proj g|=  2.11775D-03

At iterate  207    f=  1.96164D-01    |proj g|=  7.83350D-04

At iterate  208    f=  1.95246D-01    |proj g|=  6.90094D-04

At iterate  209    f=  1.93730D-01    |proj g|=  8.48564D-04

At iterate  210    f=  1.92837D-01    |proj g|=  1.00981D-03

At iterate  211    f=  1.91928D-01    |proj g|=  6.44287D-04

At iterate  212    f=  1.90680D-01    |proj g|=  7.14918D-04

At iterate  213    f=  1.89728D-01    |proj g|=  1.73324D-03

At iterate  214    f=  1.88615D-01    |proj g|=  1.07010D-03

At iterate  215    f=  1.87475D-01    |proj g|=  6.88537D-04

At iterate  216    f=  1.86771D-01    |proj g|=  7.98140D-04

At iterate  217    f=  1.85422D-01    |proj g|=  9.70533D-04

At iterate  218    f=  1.84659D-01    |proj g|=  1.32642D-03

At iterate  219    f=  1.83420D-01    |proj g|=  7.87435D-04

At iterate  220    f=  1.82628D-01    |proj g|=  6.08469D-04

At iterate  221    f=  1.81576D-01    |proj g|=  7.37378D-04

At iterate  222    f=  1.80814D-01    |proj g|=  9.88099D-04

At iterate  223    f=  1.79944D-01    |proj g|=  6.10474D-04

At iterate  224    f=  1.79178D-01    |proj g|=  5.77443D-04
```

```
At iterate  225    f=  1.78336D-01    |proj g|=  5.66040D-04

At iterate  226    f=  1.77561D-01    |proj g|=  1.82807D-03

At iterate  227    f=  1.76421D-01    |proj g|=  6.99483D-04

At iterate  228    f=  1.75859D-01    |proj g|=  5.78344D-04

At iterate  229    f=  1.75232D-01    |proj g|=  8.64790D-04

At iterate  230    f=  1.74552D-01    |proj g|=  6.72869D-04

At iterate  231    f=  1.73743D-01    |proj g|=  8.05337D-04

At iterate  232    f=  1.72515D-01    |proj g|=  6.28368D-04

At iterate  233    f=  1.71989D-01    |proj g|=  1.46724D-03

At iterate  234    f=  1.71013D-01    |proj g|=  7.61973D-04

At iterate  235    f=  1.70423D-01    |proj g|=  5.69434D-04

At iterate  236    f=  1.69822D-01    |proj g|=  6.94377D-04

At iterate  237    f=  1.68665D-01    |proj g|=  8.13659D-04

At iterate  238    f=  1.68230D-01    |proj g|=  1.22201D-03

At iterate  239    f=  1.67397D-01    |proj g|=  5.49798D-04

At iterate  240    f=  1.66836D-01    |proj g|=  6.80271D-04

At iterate  241    f=  1.65835D-01    |proj g|=  1.20818D-03

At iterate  242    f=  1.65037D-01    |proj g|=  1.11213D-03

At iterate  243    f=  1.64335D-01    |proj g|=  6.49298D-04

At iterate  244    f=  1.63652D-01    |proj g|=  5.91447D-04

At iterate  245    f=  1.63141D-01    |proj g|=  6.75784D-04

At iterate  246    f=  1.62132D-01    |proj g|=  9.65728D-04

At iterate  247    f=  1.61586D-01    |proj g|=  1.09542D-03

At iterate  248    f=  1.60705D-01    |proj g|=  5.11852D-04

At iterate  249    f=  1.60133D-01    |proj g|=  4.10001D-04

At iterate  250    f=  1.59396D-01    |proj g|=  5.37376D-04

At iterate  251    f=  1.58763D-01    |proj g|=  1.06884D-03

At iterate  252    f=  1.57838D-01    |proj g|=  7.32905D-04

At iterate  253    f=  1.57140D-01    |proj g|=  6.46027D-04
```

```
At iterate  254    f=  1.56612D-01    |proj g|=  7.82150D-04

At iterate  255    f=  1.55989D-01    |proj g|=  6.29905D-04

At iterate  256    f=  1.54854D-01    |proj g|=  6.64245D-04

At iterate  257    f=  1.53882D-01    |proj g|=  6.95157D-04

At iterate  258    f=  1.53453D-01    |proj g|=  9.26745D-04

At iterate  259    f=  1.53022D-01    |proj g|=  4.77417D-04

At iterate  260    f=  1.52577D-01    |proj g|=  5.02408D-04

At iterate  261    f=  1.51926D-01    |proj g|=  6.84004D-04

At iterate  262    f=  1.51070D-01    |proj g|=  9.71750D-04

At iterate  263    f=  1.50267D-01    |proj g|=  8.67217D-04

At iterate  264    f=  1.49652D-01    |proj g|=  6.13855D-04

At iterate  265    f=  1.49144D-01    |proj g|=  5.77820D-04

At iterate  266    f=  1.48737D-01    |proj g|=  7.46306D-04

At iterate  267    f=  1.48028D-01    |proj g|=  7.22990D-04

At iterate  268    f=  1.47450D-01    |proj g|=  6.01006D-04

At iterate  269    f=  1.47040D-01    |proj g|=  4.77195D-04

At iterate  270    f=  1.46210D-01    |proj g|=  8.15238D-04

At iterate  271    f=  1.45912D-01    |proj g|=  1.16822D-03

At iterate  272    f=  1.45297D-01    |proj g|=  5.35074D-04

At iterate  273    f=  1.44968D-01    |proj g|=  4.30288D-04

At iterate  274    f=  1.44511D-01    |proj g|=  4.64509D-04

At iterate  275    f=  1.43666D-01    |proj g|=  6.24677D-04

At iterate  276    f=  1.43297D-01    |proj g|=  7.52374D-04

At iterate  277    f=  1.42734D-01    |proj g|=  4.54841D-04

At iterate  278    f=  1.42183D-01    |proj g|=  4.39820D-04

At iterate  279    f=  1.41548D-01    |proj g|=  7.18168D-04

At iterate  280    f=  1.41059D-01    |proj g|=  7.14390D-04

At iterate  281    f=  1.40673D-01    |proj g|=  6.38692D-04
```

```
At iterate  282    f=  1.40241D-01    |proj g|=  6.73329D-04

At iterate  283    f=  1.39767D-01    |proj g|=  5.01839D-04

At iterate  284    f=  1.39375D-01    |proj g|=  1.09404D-03

At iterate  285    f=  1.38847D-01    |proj g|=  7.73825D-04

At iterate  286    f=  1.38436D-01    |proj g|=  4.30169D-04

At iterate  287    f=  1.38029D-01    |proj g|=  5.51063D-04

At iterate  288    f=  1.37511D-01    |proj g|=  8.43568D-04

At iterate  289    f=  1.37044D-01    |proj g|=  6.42497D-04

At iterate  290    f=  1.36706D-01    |proj g|=  3.88504D-04

At iterate  291    f=  1.36265D-01    |proj g|=  5.00533D-04

At iterate  292    f=  1.35903D-01    |proj g|=  5.87417D-04

At iterate  293    f=  1.35434D-01    |proj g|=  1.18219D-03

At iterate  294    f=  1.34879D-01    |proj g|=  6.13158D-04

At iterate  295    f=  1.34613D-01    |proj g|=  6.02639D-04

At iterate  296    f=  1.34161D-01    |proj g|=  4.94944D-04

At iterate  297    f=  1.33653D-01    |proj g|=  1.37025D-03

At iterate  298    f=  1.32980D-01    |proj g|=  6.59426D-04

At iterate  299    f=  1.32334D-01    |proj g|=  4.51556D-04

At iterate  300    f=  1.31901D-01    |proj g|=  5.26309D-04

At iterate  301    f=  1.31469D-01    |proj g|=  6.30996D-04

At iterate  302    f=  1.30991D-01    |proj g|=  7.23559D-04

At iterate  303    f=  1.30546D-01    |proj g|=  5.67539D-04

At iterate  304    f=  1.29397D-01    |proj g|=  5.97306D-04

At iterate  305    f=  1.29095D-01    |proj g|=  1.33501D-03

At iterate  306    f=  1.28475D-01    |proj g|=  5.78349D-04

At iterate  307    f=  1.28170D-01    |proj g|=  5.60135D-04

At iterate  308    f=  1.27672D-01    |proj g|=  4.90249D-04

At iterate  309    f=  1.27040D-01    |proj g|=  5.51365D-04

At iterate  310    f=  1.26655D-01    |proj g|=  7.54968D-04
```

```
At iterate  311    f=  1.26155D-01    |proj g|=  4.07961D-04

At iterate  312    f=  1.25773D-01    |proj g|=  4.64307D-04

At iterate  313    f=  1.25150D-01    |proj g|=  8.61777D-04

At iterate  314    f=  1.24662D-01    |proj g|=  5.86830D-04

At iterate  315    f=  1.24310D-01    |proj g|=  5.32740D-04

At iterate  316    f=  1.23979D-01    |proj g|=  5.48218D-04

At iterate  317    f=  1.23444D-01    |proj g|=  5.68421D-04

At iterate  318    f=  1.23093D-01    |proj g|=  5.66656D-04

At iterate  319    f=  1.22677D-01    |proj g|=  4.10797D-04

At iterate  320    f=  1.22364D-01    |proj g|=  5.68002D-04

At iterate  321    f=  1.21971D-01    |proj g|=  5.40986D-04

At iterate  322    f=  1.21425D-01    |proj g|=  4.53767D-04

At iterate  323    f=  1.21142D-01    |proj g|=  5.59523D-04

At iterate  324    f=  1.20833D-01    |proj g|=  3.94205D-04

At iterate  325    f=  1.20506D-01    |proj g|=  4.76230D-04

At iterate  326    f=  1.20140D-01    |proj g|=  6.50676D-04

At iterate  327    f=  1.19740D-01    |proj g|=  7.34885D-04

At iterate  328    f=  1.19356D-01    |proj g|=  4.30712D-04

At iterate  329    f=  1.18973D-01    |proj g|=  5.10846D-04

At iterate  330    f=  1.18662D-01    |proj g|=  6.28561D-04

At iterate  331    f=  1.18374D-01    |proj g|=  8.96652D-04

At iterate  332    f=  1.18079D-01    |proj g|=  3.85534D-04

At iterate  333    f=  1.17894D-01    |proj g|=  4.66102D-04

At iterate  334    f=  1.17628D-01    |proj g|=  4.98264D-04

At iterate  335    f=  1.17070D-01    |proj g|=  6.03931D-04

At iterate  336    f=  1.16814D-01    |proj g|=  6.50743D-04

At iterate  337    f=  1.16387D-01    |proj g|=  3.99709D-04

At iterate  338    f=  1.16007D-01    |proj g|=  6.57946D-04
```

```
At iterate  339    f=  1.15722D-01    |proj g|=  1.02568D-03

At iterate  340    f=  1.15417D-01    |proj g|=  4.98339D-04

At iterate  341    f=  1.15068D-01    |proj g|=  3.96306D-04

At iterate  342    f=  1.14852D-01    |proj g|=  4.71552D-04

At iterate  343    f=  1.14331D-01    |proj g|=  5.30991D-04

At iterate  344    f=  1.14185D-01    |proj g|=  8.02397D-04

At iterate  345    f=  1.13869D-01    |proj g|=  3.99312D-04

At iterate  346    f=  1.13587D-01    |proj g|=  3.48113D-04

At iterate  347    f=  1.13229D-01    |proj g|=  8.85953D-04

At iterate  348    f=  1.12891D-01    |proj g|=  5.40517D-04

At iterate  349    f=  1.12622D-01    |proj g|=  3.61155D-04

At iterate  350    f=  1.12138D-01    |proj g|=  4.06653D-04

At iterate  351    f=  1.11827D-01    |proj g|=  6.61118D-04

At iterate  352    f=  1.11448D-01    |proj g|=  4.32051D-04

At iterate  353    f=  1.11091D-01    |proj g|=  5.33473D-04

At iterate  354    f=  1.10859D-01    |proj g|=  8.87865D-04

At iterate  355    f=  1.10642D-01    |proj g|=  5.30278D-04

At iterate  356    f=  1.10314D-01    |proj g|=  5.87005D-04

At iterate  357    f=  1.10088D-01    |proj g|=  7.25192D-04

At iterate  358    f=  1.09761D-01    |proj g|=  1.06888D-03

At iterate  359    f=  1.09427D-01    |proj g|=  5.57847D-04

At iterate  360    f=  1.09270D-01    |proj g|=  3.63949D-04

At iterate  361    f=  1.08998D-01    |proj g|=  4.03629D-04

At iterate  362    f=  1.08709D-01    |proj g|=  6.51587D-04

At iterate  363    f=  1.08336D-01    |proj g|=  7.15177D-04

At iterate  364    f=  1.08039D-01    |proj g|=  5.06903D-04

At iterate  365    f=  1.07739D-01    |proj g|=  4.00368D-04

At iterate  366    f=  1.07487D-01    |proj g|=  4.82218D-04

At iterate  367    f=  1.07090D-01    |proj g|=  3.70229D-04
```

```
At iterate  368    f=  1.06896D-01    |proj g|=  1.29771D-03

At iterate  369    f=  1.06581D-01    |proj g|=  4.11277D-04

At iterate  370    f=  1.06384D-01    |proj g|=  3.67245D-04

At iterate  371    f=  1.06150D-01    |proj g|=  5.70114D-04

At iterate  372    f=  1.05759D-01    |proj g|=  5.96931D-04

At iterate  373    f=  1.05561D-01    |proj g|=  7.29718D-04

At iterate  374    f=  1.05341D-01    |proj g|=  4.69637D-04

At iterate  375    f=  1.05187D-01    |proj g|=  3.57676D-04

At iterate  376    f=  1.05007D-01    |proj g|=  5.71536D-04

At iterate  377    f=  1.04777D-01    |proj g|=  8.65242D-04

At iterate  378    f=  1.04463D-01    |proj g|=  5.79864D-04

At iterate  379    f=  1.04269D-01    |proj g|=  3.57396D-04

At iterate  380    f=  1.04079D-01    |proj g|=  3.34591D-04

At iterate  381    f=  1.03837D-01    |proj g|=  4.66833D-04

At iterate  382    f=  1.03562D-01    |proj g|=  8.59524D-04

At iterate  383    f=  1.03157D-01    |proj g|=  4.77956D-04

At iterate  384    f=  1.02979D-01    |proj g|=  2.97144D-04

At iterate  385    f=  1.02715D-01    |proj g|=  4.20108D-04

At iterate  386    f=  1.02576D-01    |proj g|=  6.97128D-04

At iterate  387    f=  1.02355D-01    |proj g|=  3.93725D-04

At iterate  388    f=  1.02044D-01    |proj g|=  3.75847D-04

At iterate  389    f=  1.01841D-01    |proj g|=  3.74504D-04

At iterate  390    f=  1.01435D-01    |proj g|=  5.58207D-04

At iterate  391    f=  1.01217D-01    |proj g|=  5.50528D-04

At iterate  392    f=  1.00991D-01    |proj g|=  3.36742D-04

At iterate  393    f=  1.00815D-01    |proj g|=  3.79529D-04

At iterate  394    f=  1.00602D-01    |proj g|=  3.82017D-04

At iterate  395    f=  1.00351D-01    |proj g|=  6.99623D-04
```

```
At iterate  396    f=  1.00076D-01    |proj g|=  2.86571D-04

At iterate  397    f=  9.99094D-02    |proj g|=  2.78517D-04

At iterate  398    f=  9.97711D-02    |proj g|=  5.73876D-04

At iterate  399    f=  9.95814D-02    |proj g|=  3.01340D-04

At iterate  400    f=  9.93424D-02    |proj g|=  4.20108D-04

           * * *

Tit   = total number of iterations
Tnf   = total number of function evaluations
Tnint = total number of segments explored during Cauchy searches
Skip  = number of BFGS updates skipped
Nact  = number of active bounds at final generalized Cauchy point
Projg = norm of the final projected gradient
F     = final function value

           * * *

   N    Tit     Tnf  Tnint  Skip  Nact     Projg        F
 7840    400    425      1     0     0   4.201D-04   9.934D-02
  F =   9.9342390772945516E-002

STOP: TOTAL NO. of ITERATIONS REACHED LIMIT
Training accuracy 0.975667, test accuracy 0.8602
15
(784, 30000)
(30000,)
Training classifier on 30000 points...
RUNNING THE L-BFGS-B CODE

           * * *

Machine precision = 2.220D-16
 N =         7840     M =           10

At X0         0 variables are exactly at the bounds

At iterate    0    f=  1.12267D+00    |proj g|=  3.05655D-03

At iterate    1    f=  1.11865D+00    |proj g|=  3.01930D-03
 This problem is unconstrained.
At iterate    2    f=  1.11433D+00    |proj g|=  2.67786D-03

At iterate    3    f=  1.09375D+00    |proj g|=  2.92045D-03

At iterate    4    f=  1.08579D+00    |proj g|=  4.28434D-03

At iterate    5    f=  1.07565D+00    |proj g|=  2.87512D-03

At iterate    6    f=  1.06295D+00    |proj g|=  2.01197D-03

At iterate    7    f=  1.05560D+00    |proj g|=  2.20455D-03
```

```
At iterate    8    f=  1.04239D+00    |proj g|=  2.90041D-03

At iterate    9    f=  1.03173D+00    |proj g|=  3.42608D-03

At iterate   10    f=  1.01676D+00    |proj g|=  1.84330D-03

At iterate   11    f=  1.00536D+00    |proj g|=  1.54312D-03

At iterate   12    f=  9.93117D-01    |proj g|=  1.92653D-03

At iterate   13    f=  9.81003D-01    |proj g|=  3.20375D-03

At iterate   14    f=  9.71808D-01    |proj g|=  3.52597D-03

At iterate   15    f=  9.61927D-01    |proj g|=  1.60110D-03

At iterate   16    f=  9.55994D-01    |proj g|=  1.61805D-03

At iterate   17    f=  9.46627D-01    |proj g|=  2.29803D-03

At iterate   18    f=  9.39598D-01    |proj g|=  3.41320D-03

At iterate   19    f=  9.30711D-01    |proj g|=  1.45586D-03

At iterate   20    f=  9.24730D-01    |proj g|=  1.20367D-03

At iterate   21    f=  9.14121D-01    |proj g|=  1.98398D-03

At iterate   22    f=  9.09108D-01    |proj g|=  3.33282D-03

At iterate   23    f=  9.00844D-01    |proj g|=  2.16649D-03

At iterate   24    f=  8.89672D-01    |proj g|=  1.35821D-03

At iterate   25    f=  8.80811D-01    |proj g|=  1.52392D-03

At iterate   26    f=  8.69493D-01    |proj g|=  2.00942D-03

At iterate   27    f=  8.62398D-01    |proj g|=  2.67323D-03

At iterate   28    f=  8.55980D-01    |proj g|=  1.30618D-03

At iterate   29    f=  8.48575D-01    |proj g|=  1.58371D-03

At iterate   30    f=  8.42350D-01    |proj g|=  2.87146D-03

At iterate   31    f=  8.33267D-01    |proj g|=  2.12286D-03

At iterate   32    f=  8.24509D-01    |proj g|=  1.70687D-03

At iterate   33    f=  8.15636D-01    |proj g|=  1.72671D-03

At iterate   34    f=  8.08262D-01    |proj g|=  1.48681D-03

At iterate   35    f=  7.98581D-01    |proj g|=  1.51082D-03

At iterate   36    f=  7.91200D-01    |proj g|=  2.15927D-03
```

```
At iterate   37    f=  7.83936D-01    |proj g|=  1.93467D-03

At iterate   38    f=  7.77064D-01    |proj g|=  1.37927D-03

At iterate   39    f=  7.71075D-01    |proj g|=  1.81944D-03

At iterate   40    f=  7.64593D-01    |proj g|=  2.96306D-03

At iterate   41    f=  7.59057D-01    |proj g|=  1.76120D-03

At iterate   42    f=  7.53916D-01    |proj g|=  1.37733D-03

At iterate   43    f=  7.47351D-01    |proj g|=  2.15828D-03

At iterate   44    f=  7.45271D-01    |proj g|=  3.89963D-03

At iterate   45    f=  7.40038D-01    |proj g|=  1.61648D-03

At iterate   46    f=  7.36897D-01    |proj g|=  9.48717D-04

At iterate   47    f=  7.32653D-01    |proj g|=  1.66043D-03

At iterate   48    f=  7.26941D-01    |proj g|=  1.63647D-03

At iterate   49    f=  7.23941D-01    |proj g|=  4.06605D-03

At iterate   50    f=  7.17961D-01    |proj g|=  1.68436D-03

At iterate   51    f=  7.13752D-01    |proj g|=  1.36196D-03

At iterate   52    f=  7.09271D-01    |proj g|=  1.89328D-03

At iterate   53    f=  7.06107D-01    |proj g|=  3.15833D-03

At iterate   54    f=  7.01902D-01    |proj g|=  1.65224D-03

At iterate   55    f=  6.97796D-01    |proj g|=  1.63963D-03

At iterate   56    f=  6.95123D-01    |proj g|=  1.51110D-03

At iterate   57    f=  6.90225D-01    |proj g|=  1.70386D-03

At iterate   58    f=  6.87266D-01    |proj g|=  2.98296D-03

At iterate   59    f=  6.81837D-01    |proj g|=  2.24532D-03

At iterate   60    f=  6.74769D-01    |proj g|=  1.49054D-03

At iterate   61    f=  6.70014D-01    |proj g|=  1.48661D-03

At iterate   62    f=  6.66718D-01    |proj g|=  4.83113D-03

At iterate   63    f=  6.61654D-01    |proj g|=  1.92756D-03

At iterate   64    f=  6.58247D-01    |proj g|=  1.12476D-03
```

```
At iterate   65    f=  6.55765D-01    |proj g|=  1.65693D-03

At iterate   66    f=  6.50546D-01    |proj g|=  2.02283D-03

At iterate   67    f=  6.47600D-01    |proj g|=  3.14135D-03

At iterate   68    f=  6.41335D-01    |proj g|=  1.24636D-03

At iterate   69    f=  6.37467D-01    |proj g|=  1.76169D-03

At iterate   70    f=  6.32483D-01    |proj g|=  1.79261D-03

At iterate   71    f=  6.27843D-01    |proj g|=  2.25574D-03

At iterate   72    f=  6.22890D-01    |proj g|=  1.58410D-03

At iterate   73    f=  6.18607D-01    |proj g|=  1.55140D-03

At iterate   74    f=  6.14145D-01    |proj g|=  1.47971D-03

At iterate   75    f=  6.10863D-01    |proj g|=  3.78537D-03

At iterate   76    f=  6.05522D-01    |proj g|=  1.98399D-03

At iterate   77    f=  6.01756D-01    |proj g|=  1.40564D-03

At iterate   78    f=  5.96525D-01    |proj g|=  1.40848D-03

At iterate   79    f=  5.93177D-01    |proj g|=  2.72673D-03

At iterate   80    f=  5.89358D-01    |proj g|=  1.54679D-03

At iterate   81    f=  5.86366D-01    |proj g|=  1.38273D-03

At iterate   82    f=  5.82035D-01    |proj g|=  1.48452D-03

At iterate   83    f=  5.78188D-01    |proj g|=  3.23616D-03

At iterate   84    f=  5.73968D-01    |proj g|=  1.37650D-03

At iterate   85    f=  5.71410D-01    |proj g|=  1.17221D-03

At iterate   86    f=  5.68756D-01    |proj g|=  1.31884D-03

At iterate   87    f=  5.63386D-01    |proj g|=  1.42508D-03

At iterate   88    f=  5.62416D-01    |proj g|=  6.57240D-03

At iterate   89    f=  5.56834D-01    |proj g|=  1.60655D-03

At iterate   90    f=  5.55323D-01    |proj g|=  9.81995D-04

At iterate   91    f=  5.53053D-01    |proj g|=  1.31984D-03

At iterate   92    f=  5.49976D-01    |proj g|=  1.62203D-03

At iterate   93    f=  5.47483D-01    |proj g|=  2.87910D-03
```

```
At iterate   94    f=  5.44815D-01    |proj g|=  1.12838D-03

At iterate   95    f=  5.42827D-01    |proj g|=  1.40074D-03

At iterate   96    f=  5.41029D-01    |proj g|=  1.54587D-03

At iterate   97    f=  5.36201D-01    |proj g|=  2.11430D-03

At iterate   98    f=  5.33275D-01    |proj g|=  2.11788D-03

At iterate   99    f=  5.30164D-01    |proj g|=  1.21355D-03

At iterate  100    f=  5.27247D-01    |proj g|=  1.48714D-03

At iterate  101    f=  5.24915D-01    |proj g|=  1.74360D-03

At iterate  102    f=  5.23026D-01    |proj g|=  3.86189D-03

At iterate  103    f=  5.20142D-01    |proj g|=  1.16342D-03

At iterate  104    f=  5.18327D-01    |proj g|=  1.24220D-03

At iterate  105    f=  5.16640D-01    |proj g|=  1.53310D-03

At iterate  106    f=  5.12761D-01    |proj g|=  1.68819D-03

At iterate  107    f=  5.08340D-01    |proj g|=  3.15486D-03

At iterate  108    f=  5.03602D-01    |proj g|=  1.21838D-03

At iterate  109    f=  5.01440D-01    |proj g|=  8.35499D-04

At iterate  110    f=  4.98591D-01    |proj g|=  1.49198D-03

At iterate  111    f=  4.96490D-01    |proj g|=  1.82323D-03

At iterate  112    f=  4.94391D-01    |proj g|=  1.05893D-03

At iterate  113    f=  4.91072D-01    |proj g|=  1.48378D-03

At iterate  114    f=  4.88938D-01    |proj g|=  9.26412D-04

At iterate  115    f=  4.86775D-01    |proj g|=  3.05938D-03

At iterate  116    f=  4.83988D-01    |proj g|=  1.23997D-03

At iterate  117    f=  4.82441D-01    |proj g|=  1.11774D-03

At iterate  118    f=  4.79445D-01    |proj g|=  1.43330D-03

At iterate  119    f=  4.76416D-01    |proj g|=  2.03739D-03

At iterate  120    f=  4.75236D-01    |proj g|=  3.36385D-03

At iterate  121    f=  4.72445D-01    |proj g|=  9.15579D-04
```

```
At iterate  122    f=  4.71207D-01    |proj g|=  1.03110D-03

At iterate  123    f=  4.68667D-01    |proj g|=  1.34413D-03

At iterate  124    f=  4.65209D-01    |proj g|=  1.39317D-03

At iterate  125    f=  4.63336D-01    |proj g|=  2.12224D-03

At iterate  126    f=  4.60219D-01    |proj g|=  1.16609D-03

At iterate  127    f=  4.58245D-01    |proj g|=  1.04290D-03

At iterate  128    f=  4.56117D-01    |proj g|=  1.61210D-03

At iterate  129    f=  4.54741D-01    |proj g|=  2.83451D-03

At iterate  130    f=  4.52659D-01    |proj g|=  9.08349D-04

At iterate  131    f=  4.51125D-01    |proj g|=  1.19765D-03

At iterate  132    f=  4.49663D-01    |proj g|=  1.43126D-03

At iterate  133    f=  4.47450D-01    |proj g|=  3.30057D-03

At iterate  134    f=  4.44405D-01    |proj g|=  1.46455D-03

At iterate  135    f=  4.42923D-01    |proj g|=  9.13750D-04

At iterate  136    f=  4.41259D-01    |proj g|=  1.05521D-03

At iterate  137    f=  4.39201D-01    |proj g|=  1.49849D-03

At iterate  138    f=  4.38622D-01    |proj g|=  3.43031D-03

At iterate  139    f=  4.35170D-01    |proj g|=  1.20353D-03

At iterate  140    f=  4.34159D-01    |proj g|=  9.49698D-04

At iterate  141    f=  4.32734D-01    |proj g|=  9.18016D-04

At iterate  142    f=  4.30652D-01    |proj g|=  1.13117D-03

At iterate  143    f=  4.28925D-01    |proj g|=  2.43110D-03

At iterate  144    f=  4.26004D-01    |proj g|=  9.63685D-04

At iterate  145    f=  4.24768D-01    |proj g|=  9.58043D-04

At iterate  146    f=  4.23061D-01    |proj g|=  2.87060D-03

At iterate  147    f=  4.21176D-01    |proj g|=  1.03968D-03

At iterate  148    f=  4.20098D-01    |proj g|=  7.80567D-04

At iterate  149    f=  4.18371D-01    |proj g|=  9.94119D-04

At iterate  150    f=  4.16455D-01    |proj g|=  1.14625D-03
```

```
At iterate  151    f=  4.15480D-01    |proj g|=  2.09287D-03

At iterate  152    f=  4.13286D-01    |proj g|=  1.19521D-03

At iterate  153    f=  4.11683D-01    |proj g|=  8.09195D-04

At iterate  154    f=  4.08696D-01    |proj g|=  1.04069D-03

At iterate  155    f=  4.06506D-01    |proj g|=  1.96091D-03

At iterate  156    f=  4.04697D-01    |proj g|=  1.80937D-03

At iterate  157    f=  4.03177D-01    |proj g|=  9.13660D-04

At iterate  158    f=  4.01872D-01    |proj g|=  1.01861D-03

At iterate  159    f=  4.00496D-01    |proj g|=  1.10787D-03

At iterate  160    f=  3.97417D-01    |proj g|=  1.50413D-03

At iterate  161    f=  3.96238D-01    |proj g|=  2.75111D-03

At iterate  162    f=  3.93896D-01    |proj g|=  1.31169D-03

At iterate  163    f=  3.92926D-01    |proj g|=  9.95240D-04

At iterate  164    f=  3.91071D-01    |proj g|=  9.90896D-04

At iterate  165    f=  3.89916D-01    |proj g|=  1.75961D-03

At iterate  166    f=  3.88211D-01    |proj g|=  1.16758D-03

At iterate  167    f=  3.86646D-01    |proj g|=  8.61899D-04

At iterate  168    f=  3.85569D-01    |proj g|=  1.20254D-03

At iterate  169    f=  3.84015D-01    |proj g|=  1.73544D-03

At iterate  170    f=  3.82311D-01    |proj g|=  1.03095D-03

At iterate  171    f=  3.79977D-01    |proj g|=  6.93581D-04

At iterate  172    f=  3.78501D-01    |proj g|=  1.06149D-03

At iterate  173    f=  3.76540D-01    |proj g|=  1.00327D-03

At iterate  174    f=  3.76078D-01    |proj g|=  3.97691D-03

At iterate  175    f=  3.73521D-01    |proj g|=  1.02720D-03

At iterate  176    f=  3.72850D-01    |proj g|=  7.07988D-04

At iterate  177    f=  3.71689D-01    |proj g|=  7.94437D-04

At iterate  178    f=  3.70124D-01    |proj g|=  1.21969D-03
```

```
At iterate  179    f=  3.69038D-01    |proj g|=  1.71604D-03

At iterate  180    f=  3.67257D-01    |proj g|=  1.00102D-03

At iterate  181    f=  3.66334D-01    |proj g|=  1.03781D-03

At iterate  182    f=  3.65306D-01    |proj g|=  1.32804D-03

At iterate  183    f=  3.64135D-01    |proj g|=  8.73783D-04

At iterate  184    f=  3.62290D-01    |proj g|=  1.06968D-03

At iterate  185    f=  3.60840D-01    |proj g|=  1.01225D-03

At iterate  186    f=  3.59980D-01    |proj g|=  2.68823D-03

At iterate  187    f=  3.57711D-01    |proj g|=  8.37657D-04

At iterate  188    f=  3.56867D-01    |proj g|=  8.84370D-04

At iterate  189    f=  3.55227D-01    |proj g|=  1.42276D-03

At iterate  190    f=  3.54665D-01    |proj g|=  2.20632D-03

At iterate  191    f=  3.52947D-01    |proj g|=  9.95985D-04

At iterate  192    f=  3.52020D-01    |proj g|=  6.13035D-04

At iterate  193    f=  3.51089D-01    |proj g|=  8.26876D-04

At iterate  194    f=  3.49947D-01    |proj g|=  1.26370D-03

At iterate  195    f=  3.48486D-01    |proj g|=  1.01170D-03

At iterate  196    f=  3.47360D-01    |proj g|=  8.46365D-04

At iterate  197    f=  3.46332D-01    |proj g|=  1.59895D-03

At iterate  198    f=  3.45351D-01    |proj g|=  9.53887D-04

At iterate  199    f=  3.44580D-01    |proj g|=  1.25438D-03

At iterate  200    f=  3.43183D-01    |proj g|=  1.28006D-03

At iterate  201    f=  3.41645D-01    |proj g|=  1.20344D-03

At iterate  202    f=  3.40968D-01    |proj g|=  2.07542D-03

At iterate  203    f=  3.39675D-01    |proj g|=  8.87275D-04

At iterate  204    f=  3.39007D-01    |proj g|=  6.99959D-04

At iterate  205    f=  3.37724D-01    |proj g|=  1.01532D-03

At iterate  206    f=  3.36335D-01    |proj g|=  1.17978D-03

At iterate  207    f=  3.35994D-01    |proj g|=  2.20208D-03
```

```
At iterate  208    f=  3.34477D-01    |proj g|=  8.10776D-04

At iterate  209    f=  3.33924D-01    |proj g|=  8.13253D-04

At iterate  210    f=  3.32620D-01    |proj g|=  1.04736D-03

At iterate  211    f=  3.31759D-01    |proj g|=  1.97406D-03

At iterate  212    f=  3.30488D-01    |proj g|=  1.05353D-03

At iterate  213    f=  3.29540D-01    |proj g|=  8.36292D-04

At iterate  214    f=  3.28627D-01    |proj g|=  9.09095D-04

At iterate  215    f=  3.27572D-01    |proj g|=  1.53104D-03

At iterate  216    f=  3.26586D-01    |proj g|=  1.29362D-03

At iterate  217    f=  3.25840D-01    |proj g|=  8.22450D-04

At iterate  218    f=  3.24882D-01    |proj g|=  6.75820D-04

At iterate  219    f=  3.24203D-01    |proj g|=  7.10886D-04

At iterate  220    f=  3.23908D-01    |proj g|=  2.82968D-03

At iterate  221    f=  3.21946D-01    |proj g|=  8.00325D-04

At iterate  222    f=  3.21489D-01    |proj g|=  6.16672D-04

At iterate  223    f=  3.20729D-01    |proj g|=  8.62309D-04

At iterate  224    f=  3.19666D-01    |proj g|=  1.65905D-03

At iterate  225    f=  3.18482D-01    |proj g|=  1.07466D-03

At iterate  226    f=  3.17644D-01    |proj g|=  7.24291D-04

At iterate  227    f=  3.16683D-01    |proj g|=  8.44942D-04

At iterate  228    f=  3.16280D-01    |proj g|=  2.82295D-03

At iterate  229    f=  3.15277D-01    |proj g|=  1.10088D-03

At iterate  230    f=  3.14600D-01    |proj g|=  6.73815D-04

At iterate  231    f=  3.14189D-01    |proj g|=  8.72526D-04

At iterate  232    f=  3.13403D-01    |proj g|=  8.88165D-04

At iterate  233    f=  3.12610D-01    |proj g|=  1.75686D-03

At iterate  234    f=  3.11220D-01    |proj g|=  8.63422D-04

At iterate  235    f=  3.10399D-01    |proj g|=  6.65702D-04
```

```
At iterate  236    f=  3.09456D-01    |proj g|=  8.67399D-04

At iterate  237    f=  3.08903D-01    |proj g|=  1.69915D-03

At iterate  238    f=  3.08041D-01    |proj g|=  1.06868D-03

At iterate  239    f=  3.07157D-01    |proj g|=  8.35128D-04

At iterate  240    f=  3.06582D-01    |proj g|=  8.16584D-04

At iterate  241    f=  3.05572D-01    |proj g|=  1.55600D-03

At iterate  242    f=  3.04672D-01    |proj g|=  1.41083D-03

At iterate  243    f=  3.03732D-01    |proj g|=  8.97980D-04

At iterate  244    f=  3.03014D-01    |proj g|=  6.51364D-04

At iterate  245    f=  3.02065D-01    |proj g|=  7.35119D-04

At iterate  246    f=  3.00842D-01    |proj g|=  1.73619D-03

At iterate  247    f=  3.00150D-01    |proj g|=  2.14580D-03

At iterate  248    f=  2.99314D-01    |proj g|=  8.30871D-04

At iterate  249    f=  2.98856D-01    |proj g|=  5.80246D-04

At iterate  250    f=  2.98386D-01    |proj g|=  7.10786D-04

At iterate  251    f=  2.97149D-01    |proj g|=  1.35109D-03

At iterate  252    f=  2.96529D-01    |proj g|=  1.28541D-03

At iterate  253    f=  2.95635D-01    |proj g|=  7.59992D-04

At iterate  254    f=  2.95014D-01    |proj g|=  7.30234D-04

At iterate  255    f=  2.94553D-01    |proj g|=  2.17546D-03

At iterate  256    f=  2.93806D-01    |proj g|=  8.64404D-04

At iterate  257    f=  2.93142D-01    |proj g|=  8.81703D-04

At iterate  258    f=  2.92430D-01    |proj g|=  1.03564D-03

At iterate  259    f=  2.91295D-01    |proj g|=  1.00313D-03

At iterate  260    f=  2.90898D-01    |proj g|=  2.10802D-03

At iterate  261    f=  2.89306D-01    |proj g|=  5.99777D-04

At iterate  262    f=  2.88792D-01    |proj g|=  5.47548D-04

At iterate  263    f=  2.88185D-01    |proj g|=  8.92014D-04

At iterate  264    f=  2.87845D-01    |proj g|=  1.86159D-03
```

```
At iterate  265    f=  2.87301D-01    |proj g|=  7.97314D-04

At iterate  266    f=  2.86751D-01    |proj g|=  8.67578D-04

At iterate  267    f=  2.86315D-01    |proj g|=  1.11392D-03

At iterate  268    f=  2.85474D-01    |proj g|=  1.29361D-03

At iterate  269    f=  2.85234D-01    |proj g|=  2.46167D-03

At iterate  270    f=  2.84136D-01    |proj g|=  7.67984D-04

At iterate  271    f=  2.83765D-01    |proj g|=  6.17469D-04

At iterate  272    f=  2.83141D-01    |proj g|=  8.59609D-04

At iterate  273    f=  2.82330D-01    |proj g|=  1.07348D-03

At iterate  274    f=  2.81714D-01    |proj g|=  1.24643D-03

At iterate  275    f=  2.81073D-01    |proj g|=  5.60677D-04

At iterate  276    f=  2.80585D-01    |proj g|=  7.90833D-04

At iterate  277    f=  2.80124D-01    |proj g|=  8.00507D-04

At iterate  278    f=  2.79142D-01    |proj g|=  1.55551D-03

At iterate  279    f=  2.78396D-01    |proj g|=  1.43452D-03

At iterate  280    f=  2.77822D-01    |proj g|=  5.84609D-04

At iterate  281    f=  2.77393D-01    |proj g|=  5.72853D-04

At iterate  282    f=  2.76893D-01    |proj g|=  8.66251D-04

At iterate  283    f=  2.76443D-01    |proj g|=  1.84178D-03

At iterate  284    f=  2.75547D-01    |proj g|=  6.09642D-04

At iterate  285    f=  2.75278D-01    |proj g|=  5.66692D-04

At iterate  286    f=  2.74635D-01    |proj g|=  5.12422D-04

At iterate  287    f=  2.73776D-01    |proj g|=  1.23678D-03

At iterate  288    f=  2.73180D-01    |proj g|=  1.04297D-03

At iterate  289    f=  2.72714D-01    |proj g|=  5.11914D-04

At iterate  290    f=  2.72319D-01    |proj g|=  5.35850D-04

At iterate  291    f=  2.71871D-01    |proj g|=  5.98783D-04

At iterate  292    f=  2.71310D-01    |proj g|=  2.72963D-03
```

```
At iterate  293    f=  2.70406D-01    |proj g|=  7.07504D-04

At iterate  294    f=  2.70075D-01    |proj g|=  5.58220D-04

At iterate  295    f=  2.69511D-01    |proj g|=  6.78090D-04

At iterate  296    f=  2.69233D-01    |proj g|=  1.21677D-03

At iterate  297    f=  2.68757D-01    |proj g|=  8.03002D-04

At iterate  298    f=  2.68086D-01    |proj g|=  5.00161D-04

At iterate  299    f=  2.67415D-01    |proj g|=  6.58290D-04

At iterate  300    f=  2.66612D-01    |proj g|=  5.30636D-04

At iterate  301    f=  2.66385D-01    |proj g|=  1.02938D-03

At iterate  302    f=  2.65839D-01    |proj g|=  5.50999D-04

At iterate  303    f=  2.65412D-01    |proj g|=  4.41282D-04

At iterate  304    f=  2.64790D-01    |proj g|=  1.10610D-03

At iterate  305    f=  2.64294D-01    |proj g|=  9.38879D-04

At iterate  306    f=  2.63911D-01    |proj g|=  5.76456D-04

At iterate  307    f=  2.63563D-01    |proj g|=  5.77768D-04

At iterate  308    f=  2.63140D-01    |proj g|=  6.51551D-04

At iterate  309    f=  2.62921D-01    |proj g|=  1.92912D-03

At iterate  310    f=  2.62292D-01    |proj g|=  5.86413D-04

At iterate  311    f=  2.61998D-01    |proj g|=  5.50714D-04

At iterate  312    f=  2.61704D-01    |proj g|=  8.17808D-04

At iterate  313    f=  2.61255D-01    |proj g|=  8.11836D-04

At iterate  314    f=  2.60753D-01    |proj g|=  6.39962D-04

At iterate  315    f=  2.60375D-01    |proj g|=  4.38799D-04

At iterate  316    f=  2.59969D-01    |proj g|=  5.89827D-04

At iterate  317    f=  2.59699D-01    |proj g|=  1.15422D-03

At iterate  318    f=  2.59261D-01    |proj g|=  8.59425D-04

At iterate  319    f=  2.58622D-01    |proj g|=  1.12841D-03

At iterate  320    f=  2.58171D-01    |proj g|=  7.77834D-04

At iterate  321    f=  2.57918D-01    |proj g|=  6.50042D-04
```

```
At iterate  322    f=  2.57031D-01    |proj g|=  5.19268D-04

At iterate  323    f=  2.56712D-01    |proj g|=  7.67862D-04

At iterate  324    f=  2.56250D-01    |proj g|=  5.07783D-04

At iterate  325    f=  2.55872D-01    |proj g|=  4.67799D-04

At iterate  326    f=  2.55446D-01    |proj g|=  7.09320D-04

At iterate  327    f=  2.54919D-01    |proj g|=  6.59330D-04

At iterate  328    f=  2.54403D-01    |proj g|=  1.10241D-03

At iterate  329    f=  2.54002D-01    |proj g|=  5.81349D-04

At iterate  330    f=  2.53783D-01    |proj g|=  4.24076D-04

At iterate  331    f=  2.53319D-01    |proj g|=  9.88292D-04

At iterate  332    f=  2.52992D-01    |proj g|=  1.22872D-03

At iterate  333    f=  2.52647D-01    |proj g|=  6.33743D-04

At iterate  334    f=  2.52218D-01    |proj g|=  5.54193D-04

At iterate  335    f=  2.51935D-01    |proj g|=  6.61650D-04

At iterate  336    f=  2.50937D-01    |proj g|=  6.76353D-04

At iterate  337    f=  2.50648D-01    |proj g|=  1.00153D-03

At iterate  338    f=  2.50184D-01    |proj g|=  5.16892D-04

At iterate  339    f=  2.49846D-01    |proj g|=  4.41324D-04

At iterate  340    f=  2.49459D-01    |proj g|=  8.17682D-04

At iterate  341    f=  2.49020D-01    |proj g|=  5.96929D-04

At iterate  342    f=  2.48681D-01    |proj g|=  7.85959D-04

At iterate  343    f=  2.48415D-01    |proj g|=  4.48403D-04

At iterate  344    f=  2.48149D-01    |proj g|=  5.19952D-04

At iterate  345    f=  2.47742D-01    |proj g|=  7.32762D-04

At iterate  346    f=  2.47388D-01    |proj g|=  1.44317D-03

At iterate  347    f=  2.46796D-01    |proj g|=  6.51503D-04

At iterate  348    f=  2.46561D-01    |proj g|=  4.19122D-04

At iterate  349    f=  2.46215D-01    |proj g|=  5.85565D-04
```

```
At iterate  350    f=  2.45805D-01    |proj g|=  8.11906D-04

At iterate  351    f=  2.45591D-01    |proj g|=  9.12710D-04

At iterate  352    f=  2.45162D-01    |proj g|=  4.93253D-04

At iterate  353    f=  2.44897D-01    |proj g|=  4.13553D-04

At iterate  354    f=  2.44568D-01    |proj g|=  4.60604D-04

At iterate  355    f=  2.44362D-01    |proj g|=  1.49240D-03

At iterate  356    f=  2.44047D-01    |proj g|=  6.78957D-04

At iterate  357    f=  2.43758D-01    |proj g|=  6.29153D-04

At iterate  358    f=  2.43605D-01    |proj g|=  7.69167D-04

At iterate  359    f=  2.43168D-01    |proj g|=  9.71638D-04

At iterate  360    f=  2.43016D-01    |proj g|=  1.00908D-03

At iterate  361    f=  2.42701D-01    |proj g|=  6.08106D-04

At iterate  362    f=  2.42443D-01    |proj g|=  4.26272D-04

At iterate  363    f=  2.42111D-01    |proj g|=  6.51471D-04

At iterate  364    f=  2.41889D-01    |proj g|=  1.10074D-03

At iterate  365    f=  2.41605D-01    |proj g|=  6.46744D-04

At iterate  366    f=  2.41351D-01    |proj g|=  5.69347D-04

At iterate  367    f=  2.41156D-01    |proj g|=  4.42603D-04

At iterate  368    f=  2.40705D-01    |proj g|=  4.83730D-04

At iterate  369    f=  2.40136D-01    |proj g|=  6.01271D-04

At iterate  370    f=  2.39982D-01    |proj g|=  1.42610D-03

At iterate  371    f=  2.39417D-01    |proj g|=  8.44932D-04

At iterate  372    f=  2.39250D-01    |proj g|=  4.06373D-04

At iterate  373    f=  2.39078D-01    |proj g|=  2.97304D-04

At iterate  374    f=  2.39030D-01    |proj g|=  1.83573D-03

At iterate  375    f=  2.38553D-01    |proj g|=  6.56920D-04

At iterate  376    f=  2.38314D-01    |proj g|=  3.87651D-04

At iterate  377    f=  2.38090D-01    |proj g|=  5.64841D-04

At iterate  378    f=  2.37783D-01    |proj g|=  5.83734D-04
```

```
At iterate  379    f=  2.37549D-01    |proj g|=  9.18272D-04

At iterate  380    f=  2.37091D-01    |proj g|=  4.66829D-04

At iterate  381    f=  2.36802D-01    |proj g|=  4.28454D-04

At iterate  382    f=  2.36447D-01    |proj g|=  6.02321D-04

At iterate  383    f=  2.36282D-01    |proj g|=  6.40601D-04

At iterate  384    f=  2.36055D-01    |proj g|=  5.62240D-04

At iterate  385    f=  2.35870D-01    |proj g|=  4.93123D-04

At iterate  386    f=  2.35590D-01    |proj g|=  5.30349D-04

At iterate  387    f=  2.35400D-01    |proj g|=  1.24163D-03

At iterate  388    f=  2.35093D-01    |proj g|=  7.60244D-04

At iterate  389    f=  2.34846D-01    |proj g|=  4.91784D-04

At iterate  390    f=  2.34642D-01    |proj g|=  5.56130D-04

At iterate  391    f=  2.34334D-01    |proj g|=  6.88726D-04

At iterate  392    f=  2.34229D-01    |proj g|=  1.00713D-03

At iterate  393    f=  2.33976D-01    |proj g|=  5.70207D-04

At iterate  394    f=  2.33867D-01    |proj g|=  3.70245D-04

At iterate  395    f=  2.33670D-01    |proj g|=  4.74022D-04

At iterate  396    f=  2.33336D-01    |proj g|=  6.05855D-04

At iterate  397    f=  2.33178D-01    |proj g|=  8.35556D-04

At iterate  398    f=  2.32872D-01    |proj g|=  4.64314D-04

At iterate  399    f=  2.32657D-01    |proj g|=  4.75248D-04

At iterate  400    f=  2.32382D-01    |proj g|=  5.34387D-04

           * * *

Tit   = total number of iterations
Tnf   = total number of function evaluations
Tnint = total number of segments explored during Cauchy searches
Skip  = number of BFGS updates skipped
Nact  = number of active bounds at final generalized Cauchy point
Projg = norm of the final projected gradient
F     = final function value

           * * *
```

```
   N    Tit     Tnf  Tnint  Skip  Nact     Projg        F
 7840    400    428      1     0     0   5.344D-04   2.324D-01
  F =  0.23238191593112487

STOP: TOTAL NO. of ITERATIONS REACHED LIMIT
Training accuracy 0.9378, test accuracy 0.8832
16
(784, 60000)
(60000,)
Training classifier on 60000 points...
RUNNING THE L-BFGS-B CODE

           * * *

Machine precision = 2.220D-16
 N =         7840     M =           10

At X0         0 variables are exactly at the bounds

At iterate    0    f=  6.09507D-01    |proj g|=  7.51703D-03

At iterate    1    f=  5.90422D-01    |proj g|=  6.70801D-03
 This problem is unconstrained.
At iterate    2    f=  5.77536D-01    |proj g|=  4.77162D-03

At iterate    3    f=  5.46106D-01    |proj g|=  3.73964D-03

At iterate    4    f=  5.41676D-01    |proj g|=  1.17128D-02

At iterate    5    f=  5.27163D-01    |proj g|=  4.27887D-03

At iterate    6    f=  5.20683D-01    |proj g|=  1.70819D-03

At iterate    7    f=  5.14758D-01    |proj g|=  2.43851D-03

At iterate    8    f=  5.07678D-01    |proj g|=  2.16431D-03

At iterate    9    f=  4.96182D-01    |proj g|=  4.69666D-03

At iterate   10    f=  4.90632D-01    |proj g|=  5.28439D-03

At iterate   11    f=  4.84562D-01    |proj g|=  1.57679D-03

At iterate   12    f=  4.82116D-01    |proj g|=  1.34657D-03

At iterate   13    f=  4.79230D-01    |proj g|=  1.60041D-03

At iterate   14    f=  4.73187D-01    |proj g|=  2.13471D-03

At iterate   15    f=  4.71201D-01    |proj g|=  2.68755D-03

At iterate   16    f=  4.66895D-01    |proj g|=  1.58845D-03

At iterate   17    f=  4.63749D-01    |proj g|=  1.18568D-03

At iterate   18    f=  4.61249D-01    |proj g|=  3.95826D-03
```

```
At iterate   19    f=  4.57665D-01    |proj g|=  1.57880D-03

At iterate   20    f=  4.55581D-01    |proj g|=  1.42706D-03

At iterate   21    f=  4.53192D-01    |proj g|=  1.51682D-03

At iterate   22    f=  4.50254D-01    |proj g|=  1.53405D-03

At iterate   23    f=  4.47337D-01    |proj g|=  3.71280D-03

At iterate   24    f=  4.43019D-01    |proj g|=  1.52107D-03

At iterate   25    f=  4.41171D-01    |proj g|=  1.04230D-03

At iterate   26    f=  4.38436D-01    |proj g|=  1.45999D-03

At iterate   27    f=  4.36529D-01    |proj g|=  1.96882D-03

At iterate   28    f=  4.34469D-01    |proj g|=  1.59408D-03

At iterate   29    f=  4.32580D-01    |proj g|=  1.13416D-03

At iterate   30    f=  4.30754D-01    |proj g|=  1.14483D-03

At iterate   31    f=  4.28752D-01    |proj g|=  2.63314D-03

At iterate   32    f=  4.26360D-01    |proj g|=  1.19911D-03

At iterate   33    f=  4.24654D-01    |proj g|=  1.28543D-03

At iterate   34    f=  4.23490D-01    |proj g|=  1.17804D-03

At iterate   35    f=  4.21299D-01    |proj g|=  1.73051D-03

At iterate   36    f=  4.19665D-01    |proj g|=  2.12012D-03

At iterate   37    f=  4.18272D-01    |proj g|=  1.30290D-03

At iterate   38    f=  4.16384D-01    |proj g|=  1.23971D-03

At iterate   39    f=  4.15065D-01    |proj g|=  1.31837D-03

At iterate   40    f=  4.12273D-01    |proj g|=  1.79696D-03

At iterate   41    f=  4.10835D-01    |proj g|=  1.76356D-03

At iterate   42    f=  4.09313D-01    |proj g|=  9.08314D-04

At iterate   43    f=  4.07739D-01    |proj g|=  1.17013D-03

At iterate   44    f=  4.06145D-01    |proj g|=  1.74718D-03

At iterate   45    f=  4.05085D-01    |proj g|=  2.10984D-03

At iterate   46    f=  4.03331D-01    |proj g|=  1.31156D-03

At iterate   47    f=  4.02209D-01    |proj g|=  1.07827D-03
```

```
At iterate   48    f=  4.00617D-01    |proj g|=  9.68636D-04

At iterate   49    f=  3.98671D-01    |proj g|=  9.83584D-04

At iterate   50    f=  3.97643D-01    |proj g|=  2.31371D-03

At iterate   51    f=  3.95901D-01    |proj g|=  1.00730D-03

At iterate   52    f=  3.94688D-01    |proj g|=  8.14445D-04

At iterate   53    f=  3.93221D-01    |proj g|=  1.21519D-03

At iterate   54    f=  3.92244D-01    |proj g|=  3.46201D-03

At iterate   55    f=  3.90633D-01    |proj g|=  1.43374D-03

At iterate   56    f=  3.89402D-01    |proj g|=  7.93836D-04

At iterate   57    f=  3.88564D-01    |proj g|=  9.93966D-04

At iterate   58    f=  3.86360D-01    |proj g|=  1.26953D-03

At iterate   59    f=  3.85519D-01    |proj g|=  2.62412D-03

At iterate   60    f=  3.83440D-01    |proj g|=  1.74960D-03

At iterate   61    f=  3.82112D-01    |proj g|=  1.25015D-03

At iterate   62    f=  3.80426D-01    |proj g|=  1.05703D-03

At iterate   63    f=  3.78989D-01    |proj g|=  1.23927D-03

At iterate   64    f=  3.77690D-01    |proj g|=  1.68310D-03

At iterate   65    f=  3.76581D-01    |proj g|=  9.22025D-04

At iterate   66    f=  3.75109D-01    |proj g|=  8.29247D-04

At iterate   67    f=  3.73934D-01    |proj g|=  9.66243D-04

At iterate   68    f=  3.72344D-01    |proj g|=  2.68345D-03

At iterate   69    f=  3.70310D-01    |proj g|=  1.09232D-03

At iterate   70    f=  3.69474D-01    |proj g|=  8.40074D-04

At iterate   71    f=  3.68115D-01    |proj g|=  1.01563D-03

At iterate   72    f=  3.66952D-01    |proj g|=  1.29584D-03

At iterate   73    f=  3.65765D-01    |proj g|=  1.85272D-03

At iterate   74    f=  3.64503D-01    |proj g|=  9.39936D-04

At iterate   75    f=  3.63729D-01    |proj g|=  9.59193D-04
```

```
At iterate   76    f=  3.62768D-01    |proj g|=  9.87990D-04

At iterate   77    f=  3.61841D-01    |proj g|=  2.43258D-03

At iterate   78    f=  3.60376D-01    |proj g|=  1.24490D-03

At iterate   79    f=  3.59449D-01    |proj g|=  9.54308D-04

At iterate   80    f=  3.58192D-01    |proj g|=  1.17384D-03

At iterate   81    f=  3.56931D-01    |proj g|=  1.29443D-03

At iterate   82    f=  3.54409D-01    |proj g|=  9.91619D-04

At iterate   83    f=  3.53543D-01    |proj g|=  1.91695D-03

At iterate   84    f=  3.51838D-01    |proj g|=  1.09482D-03

At iterate   85    f=  3.50956D-01    |proj g|=  9.64386D-04

At iterate   86    f=  3.50105D-01    |proj g|=  2.52163D-03

At iterate   87    f=  3.49009D-01    |proj g|=  9.79911D-04

At iterate   88    f=  3.48109D-01    |proj g|=  1.12821D-03

At iterate   89    f=  3.47380D-01    |proj g|=  1.37526D-03

At iterate   90    f=  3.45954D-01    |proj g|=  1.32247D-03

At iterate   91    f=  3.44924D-01    |proj g|=  1.62562D-03

At iterate   92    f=  3.43783D-01    |proj g|=  8.86990D-04

At iterate   93    f=  3.42973D-01    |proj g|=  8.50578D-04

At iterate   94    f=  3.41987D-01    |proj g|=  1.24673D-03

At iterate   95    f=  3.40520D-01    |proj g|=  1.75518D-03

At iterate   96    f=  3.39224D-01    |proj g|=  1.04605D-03

At iterate   97    f=  3.38513D-01    |proj g|=  9.67905D-04

At iterate   98    f=  3.37446D-01    |proj g|=  1.00678D-03

At iterate   99    f=  3.36771D-01    |proj g|=  1.40293D-03

At iterate  100    f=  3.35832D-01    |proj g|=  7.95884D-04

At iterate  101    f=  3.35109D-01    |proj g|=  8.40768D-04

At iterate  102    f=  3.33994D-01    |proj g|=  8.22106D-04

At iterate  103    f=  3.33226D-01    |proj g|=  1.61865D-03

At iterate  104    f=  3.32036D-01    |proj g|=  8.21956D-04
```

```
At iterate  105    f=  3.31213D-01    |proj g|=  6.38257D-04

At iterate  106    f=  3.30208D-01    |proj g|=  8.17044D-04

At iterate  107    f=  3.29091D-01    |proj g|=  1.38849D-03

At iterate  108    f=  3.28112D-01    |proj g|=  1.15840D-03

At iterate  109    f=  3.27282D-01    |proj g|=  8.05696D-04

At iterate  110    f=  3.26555D-01    |proj g|=  7.68809D-04

At iterate  111    f=  3.25896D-01    |proj g|=  8.14055D-04

At iterate  112    f=  3.25449D-01    |proj g|=  4.10273D-03

At iterate  113    f=  3.23518D-01    |proj g|=  8.47419D-04

At iterate  114    f=  3.23081D-01    |proj g|=  7.41486D-04

At iterate  115    f=  3.22199D-01    |proj g|=  7.34020D-04

At iterate  116    f=  3.21047D-01    |proj g|=  1.00401D-03

At iterate  117    f=  3.20729D-01    |proj g|=  2.10744D-03

At iterate  118    f=  3.19501D-01    |proj g|=  7.32581D-04

At iterate  119    f=  3.19126D-01    |proj g|=  7.31997D-04

At iterate  120    f=  3.17980D-01    |proj g|=  8.66711D-04

At iterate  121    f=  3.17159D-01    |proj g|=  1.27200D-03

At iterate  122    f=  3.16225D-01    |proj g|=  7.42683D-04

At iterate  123    f=  3.15653D-01    |proj g|=  6.09039D-04

At iterate  124    f=  3.15085D-01    |proj g|=  1.24150D-03

At iterate  125    f=  3.14372D-01    |proj g|=  9.62653D-04

At iterate  126    f=  3.13707D-01    |proj g|=  7.72063D-04

At iterate  127    f=  3.13249D-01    |proj g|=  6.66833D-04

At iterate  128    f=  3.12510D-01    |proj g|=  6.47546D-04

At iterate  129    f=  3.10900D-01    |proj g|=  1.08860D-03

At iterate  130    f=  3.10408D-01    |proj g|=  7.55483D-04

At iterate  131    f=  3.09890D-01    |proj g|=  5.53579D-04

At iterate  132    f=  3.09367D-01    |proj g|=  5.62953D-04
```

```
At iterate  133    f=  3.08297D-01    |proj g|=  7.72358D-04

At iterate  134    f=  3.07039D-01    |proj g|=  1.07829D-03

At iterate  135    f=  3.06123D-01    |proj g|=  1.25965D-03

At iterate  136    f=  3.05152D-01    |proj g|=  7.63890D-04

At iterate  137    f=  3.04617D-01    |proj g|=  8.43641D-04

At iterate  138    f=  3.04180D-01    |proj g|=  8.90099D-04

At iterate  139    f=  3.03792D-01    |proj g|=  8.73011D-04

At iterate  140    f=  3.02914D-01    |proj g|=  1.03155D-03

At iterate  141    f=  3.02569D-01    |proj g|=  9.39063D-04

At iterate  142    f=  3.02217D-01    |proj g|=  8.60869D-04

At iterate  143    f=  3.00836D-01    |proj g|=  7.87472D-04

At iterate  144    f=  3.00363D-01    |proj g|=  1.69280D-03

At iterate  145    f=  2.99715D-01    |proj g|=  7.99447D-04

At iterate  146    f=  2.99220D-01    |proj g|=  6.40724D-04

At iterate  147    f=  2.98754D-01    |proj g|=  7.85932D-04

At iterate  148    f=  2.97863D-01    |proj g|=  8.34924D-04

At iterate  149    f=  2.97214D-01    |proj g|=  1.53597D-03

At iterate  150    f=  2.96526D-01    |proj g|=  1.22481D-03

At iterate  151    f=  2.96103D-01    |proj g|=  7.43792D-04

At iterate  152    f=  2.95611D-01    |proj g|=  6.43970D-04

At iterate  153    f=  2.94862D-01    |proj g|=  9.92883D-04

At iterate  154    f=  2.94705D-01    |proj g|=  2.63490D-03

At iterate  155    f=  2.93593D-01    |proj g|=  9.27320D-04

At iterate  156    f=  2.93328D-01    |proj g|=  6.55890D-04

At iterate  157    f=  2.92736D-01    |proj g|=  7.12541D-04

At iterate  158    f=  2.91994D-01    |proj g|=  9.13872D-04

At iterate  159    f=  2.91532D-01    |proj g|=  1.62627D-03

At iterate  160    f=  2.90907D-01    |proj g|=  6.25970D-04

At iterate  161    f=  2.90611D-01    |proj g|=  6.20138D-04
```

```
At iterate  162    f=  2.90315D-01    |proj g|=  7.28031D-04

At iterate  163    f=  2.89926D-01    |proj g|=  2.11487D-03

At iterate  164    f=  2.89204D-01    |proj g|=  1.04517D-03

At iterate  165    f=  2.88739D-01    |proj g|=  6.21577D-04

At iterate  166    f=  2.88395D-01    |proj g|=  7.21231D-04

At iterate  167    f=  2.87937D-01    |proj g|=  7.58985D-04

At iterate  168    f=  2.87617D-01    |proj g|=  1.51735D-03

At iterate  169    f=  2.86980D-01    |proj g|=  8.73538D-04

At iterate  170    f=  2.86601D-01    |proj g|=  5.72564D-04

At iterate  171    f=  2.85968D-01    |proj g|=  8.91364D-04

At iterate  172    f=  2.85511D-01    |proj g|=  1.00875D-03

At iterate  173    f=  2.85018D-01    |proj g|=  6.04583D-04

At iterate  174    f=  2.84506D-01    |proj g|=  5.86276D-04

At iterate  175    f=  2.83998D-01    |proj g|=  6.63249D-04

At iterate  176    f=  2.83563D-01    |proj g|=  1.71268D-03

At iterate  177    f=  2.82880D-01    |proj g|=  6.81877D-04

At iterate  178    f=  2.82496D-01    |proj g|=  6.66075D-04

At iterate  179    f=  2.81950D-01    |proj g|=  9.60458D-04

At iterate  180    f=  2.81351D-01    |proj g|=  7.89357D-04

At iterate  181    f=  2.80998D-01    |proj g|=  1.72040D-03

At iterate  182    f=  2.80509D-01    |proj g|=  5.99194D-04

At iterate  183    f=  2.80266D-01    |proj g|=  8.38821D-04

At iterate  184    f=  2.79987D-01    |proj g|=  8.74592D-04

At iterate  185    f=  2.79256D-01    |proj g|=  9.24391D-04

At iterate  186    f=  2.79020D-01    |proj g|=  1.50175D-03

At iterate  187    f=  2.78512D-01    |proj g|=  6.93477D-04

At iterate  188    f=  2.78128D-01    |proj g|=  6.73273D-04

At iterate  189    f=  2.77758D-01    |proj g|=  8.08608D-04
```

```
At iterate  190    f=  2.77469D-01    |proj g|=  1.17507D-03

At iterate  191    f=  2.77141D-01    |proj g|=  7.41747D-04

At iterate  192    f=  2.76745D-01    |proj g|=  6.13985D-04

At iterate  193    f=  2.76512D-01    |proj g|=  5.83712D-04

At iterate  194    f=  2.76190D-01    |proj g|=  1.36524D-03

At iterate  195    f=  2.75685D-01    |proj g|=  6.62402D-04

At iterate  196    f=  2.75423D-01    |proj g|=  4.22599D-04

At iterate  197    f=  2.75064D-01    |proj g|=  6.28744D-04

At iterate  198    f=  2.74614D-01    |proj g|=  7.25988D-04

At iterate  199    f=  2.74313D-01    |proj g|=  9.51299D-04

At iterate  200    f=  2.73927D-01    |proj g|=  4.86688D-04

At iterate  201    f=  2.73662D-01    |proj g|=  4.54203D-04

At iterate  202    f=  2.73292D-01    |proj g|=  1.23317D-03

At iterate  203    f=  2.72869D-01    |proj g|=  8.21404D-04

At iterate  204    f=  2.72463D-01    |proj g|=  5.74680D-04

At iterate  205    f=  2.71955D-01    |proj g|=  7.08769D-04

At iterate  206    f=  2.71561D-01    |proj g|=  6.70213D-04

At iterate  207    f=  2.71113D-01    |proj g|=  1.09311D-03

At iterate  208    f=  2.70664D-01    |proj g|=  7.50198D-04

At iterate  209    f=  2.70409D-01    |proj g|=  5.17354D-04

At iterate  210    f=  2.70117D-01    |proj g|=  5.10670D-04

At iterate  211    f=  2.69655D-01    |proj g|=  6.84340D-04

At iterate  212    f=  2.69012D-01    |proj g|=  1.24304D-03

At iterate  213    f=  2.68597D-01    |proj g|=  8.59497D-04

At iterate  214    f=  2.68272D-01    |proj g|=  6.30174D-04

At iterate  215    f=  2.68019D-01    |proj g|=  7.11901D-04

At iterate  216    f=  2.67799D-01    |proj g|=  1.15875D-03

At iterate  217    f=  2.67540D-01    |proj g|=  8.79743D-04

At iterate  218    f=  2.66896D-01    |proj g|=  4.37465D-04
```

```
At iterate  219    f=  2.66611D-01    |proj g|=  7.04462D-04

At iterate  220    f=  2.66230D-01    |proj g|=  6.20841D-04

At iterate  221    f=  2.65940D-01    |proj g|=  7.98442D-04

At iterate  222    f=  2.65650D-01    |proj g|=  5.73313D-04

At iterate  223    f=  2.65128D-01    |proj g|=  6.25021D-04

At iterate  224    f=  2.64762D-01    |proj g|=  6.50434D-04

At iterate  225    f=  2.64615D-01    |proj g|=  2.25024D-03

At iterate  226    f=  2.64075D-01    |proj g|=  6.72538D-04

At iterate  227    f=  2.63866D-01    |proj g|=  3.91439D-04

At iterate  228    f=  2.63521D-01    |proj g|=  5.11262D-04

At iterate  229    f=  2.63100D-01    |proj g|=  6.70466D-04

At iterate  230    f=  2.62762D-01    |proj g|=  1.24767D-03

At iterate  231    f=  2.62316D-01    |proj g|=  7.52427D-04

At iterate  232    f=  2.62120D-01    |proj g|=  7.85934D-04

At iterate  233    f=  2.61709D-01    |proj g|=  6.75057D-04

At iterate  234    f=  2.61529D-01    |proj g|=  8.74269D-04

At iterate  235    f=  2.61273D-01    |proj g|=  5.67063D-04

At iterate  236    f=  2.60982D-01    |proj g|=  6.09025D-04

At iterate  237    f=  2.60451D-01    |proj g|=  6.31082D-04

At iterate  238    f=  2.60288D-01    |proj g|=  9.84324D-04

At iterate  239    f=  2.59985D-01    |proj g|=  6.83793D-04

At iterate  240    f=  2.59685D-01    |proj g|=  4.10585D-04

At iterate  241    f=  2.59339D-01    |proj g|=  5.96971D-04

At iterate  242    f=  2.58968D-01    |proj g|=  7.40898D-04

At iterate  243    f=  2.58617D-01    |proj g|=  7.08368D-04

At iterate  244    f=  2.58320D-01    |proj g|=  4.56374D-04

At iterate  245    f=  2.57937D-01    |proj g|=  8.70439D-04

At iterate  246    f=  2.57776D-01    |proj g|=  1.22922D-03
```

```
At iterate  247    f=  2.57581D-01    |proj g|=  6.58745D-04

At iterate  248    f=  2.57294D-01    |proj g|=  4.98254D-04

At iterate  249    f=  2.57102D-01    |proj g|=  6.24929D-04

At iterate  250    f=  2.56789D-01    |proj g|=  9.94693D-04

At iterate  251    f=  2.56495D-01    |proj g|=  9.98682D-04

At iterate  252    f=  2.56305D-01    |proj g|=  7.01203D-04

At iterate  253    f=  2.55999D-01    |proj g|=  4.97340D-04

At iterate  254    f=  2.55785D-01    |proj g|=  6.99568D-04

At iterate  255    f=  2.55483D-01    |proj g|=  7.14538D-04

At iterate  256    f=  2.55111D-01    |proj g|=  5.22462D-04

At iterate  257    f=  2.54783D-01    |proj g|=  9.21351D-04

At iterate  258    f=  2.54500D-01    |proj g|=  9.52515D-04

At iterate  259    f=  2.54326D-01    |proj g|=  5.43919D-04

At iterate  260    f=  2.54060D-01    |proj g|=  5.28674D-04

At iterate  261    f=  2.53803D-01    |proj g|=  6.71443D-04

At iterate  262    f=  2.53507D-01    |proj g|=  6.26563D-04

At iterate  263    f=  2.53063D-01    |proj g|=  1.19880D-03

At iterate  264    f=  2.52937D-01    |proj g|=  1.36850D-03

At iterate  265    f=  2.52709D-01    |proj g|=  5.13444D-04

At iterate  266    f=  2.52604D-01    |proj g|=  3.41273D-04

At iterate  267    f=  2.52357D-01    |proj g|=  6.90611D-04

At iterate  268    f=  2.52049D-01    |proj g|=  7.96312D-04

At iterate  269    f=  2.51868D-01    |proj g|=  8.23660D-04

At iterate  270    f=  2.51636D-01    |proj g|=  4.13361D-04

At iterate  271    f=  2.51456D-01    |proj g|=  5.75656D-04

At iterate  272    f=  2.51273D-01    |proj g|=  7.67356D-04

At iterate  273    f=  2.51058D-01    |proj g|=  1.17544D-03

At iterate  274    f=  2.50829D-01    |proj g|=  5.57235D-04

At iterate  275    f=  2.50664D-01    |proj g|=  5.17659D-04
```

```
At iterate  276    f=  2.50555D-01    |proj g|=  5.73934D-04

At iterate  277    f=  2.50266D-01    |proj g|=  9.85509D-04

At iterate  278    f=  2.49910D-01    |proj g|=  6.79919D-04

At iterate  279    f=  2.49636D-01    |proj g|=  4.94728D-04

At iterate  280    f=  2.49414D-01    |proj g|=  4.67396D-04

At iterate  281    f=  2.49253D-01    |proj g|=  5.96326D-04

At iterate  282    f=  2.49081D-01    |proj g|=  5.26496D-04

At iterate  283    f=  2.48679D-01    |proj g|=  6.36050D-04

At iterate  284    f=  2.48505D-01    |proj g|=  1.19485D-03

At iterate  285    f=  2.48235D-01    |proj g|=  4.38940D-04

At iterate  286    f=  2.48106D-01    |proj g|=  3.27292D-04

At iterate  287    f=  2.47964D-01    |proj g|=  4.70396D-04

At iterate  288    f=  2.47783D-01    |proj g|=  1.13144D-03

At iterate  289    f=  2.47545D-01    |proj g|=  5.74984D-04

At iterate  290    f=  2.47384D-01    |proj g|=  4.00995D-04

At iterate  291    f=  2.47178D-01    |proj g|=  3.70313D-04

At iterate  292    f=  2.46964D-01    |proj g|=  6.73308D-04

At iterate  293    f=  2.46701D-01    |proj g|=  7.65661D-04

At iterate  294    f=  2.46480D-01    |proj g|=  4.74283D-04

At iterate  295    f=  2.46286D-01    |proj g|=  5.51345D-04

At iterate  296    f=  2.46157D-01    |proj g|=  8.52141D-04

At iterate  297    f=  2.46005D-01    |proj g|=  6.64262D-04

At iterate  298    f=  2.45593D-01    |proj g|=  4.66217D-04

At iterate  299    f=  2.45413D-01    |proj g|=  5.01490D-04

At iterate  300    f=  2.45189D-01    |proj g|=  1.42171D-03

At iterate  301    f=  2.44980D-01    |proj g|=  7.46162D-04

At iterate  302    f=  2.44870D-01    |proj g|=  4.68222D-04

At iterate  303    f=  2.44674D-01    |proj g|=  3.72710D-04
```

```
At iterate  304    f=  2.44454D-01    |proj g|=  4.48772D-04

At iterate  305    f=  2.44323D-01    |proj g|=  8.44094D-04

At iterate  306    f=  2.44103D-01    |proj g|=  4.72925D-04

At iterate  307    f=  2.43920D-01    |proj g|=  3.82703D-04

At iterate  308    f=  2.43720D-01    |proj g|=  6.85841D-04

At iterate  309    f=  2.43593D-01    |proj g|=  1.18974D-03

At iterate  310    f=  2.43389D-01    |proj g|=  5.33215D-04

At iterate  311    f=  2.43228D-01    |proj g|=  3.93114D-04

At iterate  312    f=  2.43109D-01    |proj g|=  4.85732D-04

At iterate  313    f=  2.42860D-01    |proj g|=  5.92928D-04

At iterate  314    f=  2.42707D-01    |proj g|=  8.13240D-04

At iterate  315    f=  2.42493D-01    |proj g|=  4.00701D-04

At iterate  316    f=  2.42366D-01    |proj g|=  3.59153D-04

At iterate  317    f=  2.42164D-01    |proj g|=  5.16850D-04

At iterate  318    f=  2.41957D-01    |proj g|=  5.36525D-04

At iterate  319    f=  2.41761D-01    |proj g|=  4.54848D-04

At iterate  320    f=  2.41544D-01    |proj g|=  7.33557D-04

At iterate  321    f=  2.41392D-01    |proj g|=  4.85539D-04

At iterate  322    f=  2.41239D-01    |proj g|=  4.83723D-04

At iterate  323    f=  2.41061D-01    |proj g|=  6.01710D-04

At iterate  324    f=  2.41017D-01    |proj g|=  1.48868D-03

At iterate  325    f=  2.40761D-01    |proj g|=  3.97023D-04

At iterate  326    f=  2.40657D-01    |proj g|=  3.56700D-04

At iterate  327    f=  2.40526D-01    |proj g|=  5.04560D-04

At iterate  328    f=  2.40401D-01    |proj g|=  7.36207D-04

At iterate  329    f=  2.40231D-01    |proj g|=  4.65631D-04

At iterate  330    f=  2.40062D-01    |proj g|=  4.27100D-04

At iterate  331    f=  2.39921D-01    |proj g|=  4.41919D-04

At iterate  332    f=  2.39710D-01    |proj g|=  4.81984D-04
```

```
At iterate  333    f=  2.39584D-01    |proj g|=  9.10630D-04

At iterate  334    f=  2.39377D-01    |proj g|=  4.55302D-04

At iterate  335    f=  2.39185D-01    |proj g|=  3.58158D-04

At iterate  336    f=  2.38975D-01    |proj g|=  4.79784D-04

At iterate  337    f=  2.38822D-01    |proj g|=  8.29824D-04

At iterate  338    f=  2.38627D-01    |proj g|=  4.74094D-04

At iterate  339    f=  2.38499D-01    |proj g|=  3.95476D-04

At iterate  340    f=  2.38350D-01    |proj g|=  5.12567D-04

At iterate  341    f=  2.38192D-01    |proj g|=  8.94575D-04

At iterate  342    f=  2.38010D-01    |proj g|=  5.74191D-04

At iterate  343    f=  2.37849D-01    |proj g|=  5.09752D-04

At iterate  344    f=  2.37732D-01    |proj g|=  4.39043D-04

At iterate  345    f=  2.37467D-01    |proj g|=  6.36276D-04

At iterate  346    f=  2.37304D-01    |proj g|=  9.37185D-04

At iterate  347    f=  2.37145D-01    |proj g|=  3.27279D-04

At iterate  348    f=  2.37057D-01    |proj g|=  3.34238D-04

At iterate  349    f=  2.36884D-01    |proj g|=  3.17667D-04

At iterate  350    f=  2.36766D-01    |proj g|=  1.11869D-03

At iterate  351    f=  2.36575D-01    |proj g|=  4.16627D-04

At iterate  352    f=  2.36465D-01    |proj g|=  3.00811D-04

At iterate  353    f=  2.36348D-01    |proj g|=  3.85783D-04

At iterate  354    f=  2.36141D-01    |proj g|=  5.36206D-04

At iterate  355    f=  2.36066D-01    |proj g|=  6.76680D-04

At iterate  356    f=  2.35927D-01    |proj g|=  5.12827D-04

At iterate  357    f=  2.35812D-01    |proj g|=  3.96834D-04

At iterate  358    f=  2.35613D-01    |proj g|=  4.76498D-04

At iterate  359    f=  2.35537D-01    |proj g|=  5.65087D-04

At iterate  360    f=  2.35411D-01    |proj g|=  4.18213D-04
```

```
At iterate  361    f=  2.35266D-01    |proj g|=  3.49786D-04

At iterate  362    f=  2.35074D-01    |proj g|=  5.17221D-04

At iterate  363    f=  2.34890D-01    |proj g|=  5.17877D-04

At iterate  364    f=  2.34735D-01    |proj g|=  6.73896D-04

At iterate  365    f=  2.34625D-01    |proj g|=  3.46985D-04

At iterate  366    f=  2.34539D-01    |proj g|=  4.90974D-04

At iterate  367    f=  2.34466D-01    |proj g|=  4.64280D-04

At iterate  368    f=  2.34289D-01    |proj g|=  1.10392D-03

At iterate  369    f=  2.34090D-01    |proj g|=  5.84889D-04

At iterate  370    f=  2.33940D-01    |proj g|=  4.30093D-04

At iterate  371    f=  2.33822D-01    |proj g|=  4.85058D-04

At iterate  372    f=  2.33712D-01    |proj g|=  4.18049D-04

At iterate  373    f=  2.33521D-01    |proj g|=  4.25420D-04

At iterate  374    f=  2.33436D-01    |proj g|=  7.71119D-04

At iterate  375    f=  2.33270D-01    |proj g|=  4.80466D-04

At iterate  376    f=  2.33149D-01    |proj g|=  3.25460D-04

At iterate  377    f=  2.33032D-01    |proj g|=  4.12585D-04

At iterate  378    f=  2.32930D-01    |proj g|=  3.78439D-04

At iterate  379    f=  2.32791D-01    |proj g|=  4.24353D-04

At iterate  380    f=  2.32680D-01    |proj g|=  6.94927D-04

At iterate  381    f=  2.32575D-01    |proj g|=  4.20810D-04

At iterate  382    f=  2.32442D-01    |proj g|=  3.58865D-04

At iterate  383    f=  2.32387D-01    |proj g|=  7.61767D-04

At iterate  384    f=  2.32309D-01    |proj g|=  5.04334D-04

At iterate  385    f=  2.32141D-01    |proj g|=  4.70636D-04

At iterate  386    f=  2.32036D-01    |proj g|=  5.00013D-04

At iterate  387    f=  2.31993D-01    |proj g|=  1.23777D-03

At iterate  388    f=  2.31802D-01    |proj g|=  3.64041D-04

At iterate  389    f=  2.31744D-01    |proj g|=  2.92649D-04
```

```
At iterate  390    f=  2.31613D-01    |proj g|=  4.08858D-04

At iterate  391    f=  2.31485D-01    |proj g|=  5.46626D-04

At iterate  392    f=  2.31428D-01    |proj g|=  6.87856D-04

At iterate  393    f=  2.31299D-01    |proj g|=  2.72241D-04

At iterate  394    f=  2.31236D-01    |proj g|=  3.57030D-04

At iterate  395    f=  2.31128D-01    |proj g|=  4.57177D-04

At iterate  396    f=  2.30985D-01    |proj g|=  6.16175D-04

At iterate  397    f=  2.30890D-01    |proj g|=  6.01676D-04

At iterate  398    f=  2.30790D-01    |proj g|=  3.88255D-04

At iterate  399    f=  2.30709D-01    |proj g|=  3.16697D-04

At iterate  400    f=  2.30628D-01    |proj g|=  4.05294D-04

           * * *

Tit   = total number of iterations
Tnf   = total number of function evaluations
Tnint = total number of segments explored during Cauchy searches
Skip  = number of BFGS updates skipped
Nact  = number of active bounds at final generalized Cauchy point
Projg = norm of the final projected gradient
F     = final function value

           * * *

   N    Tit     Tnf  Tnint  Skip  Nact     Projg        F
 7840    400    430      1     0     0   4.053D-04   2.306D-01
  F =  0.23062765740926586

STOP: TOTAL NO. of ITERATIONS REACHED LIMIT
Training accuracy 0.937233, test accuracy 0.9155
```

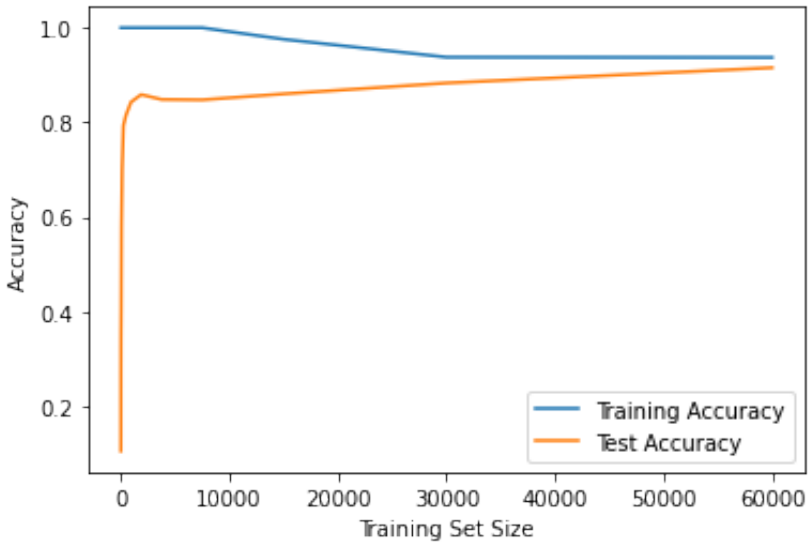
In [ ]:
```python
import matplotlib.pyplot as plt

# Create a new figure
plt.figure()

# Plot the training and test accuracies as a function of the training set
plt.plot(dataSizes, [acc for acc in trainAcc], label="Training Accuracy")
plt.plot(dataSizes, [acc for acc in testAcc], label="Test Accuracy")

# Add axis labels and a legend
plt.xlabel("Training Set Size")
plt.ylabel("Accuracy")
plt.legend()

# Display the plot
plt.show()
```



TODO

Part II NN

Qnn 1.4

When initializing the weight matrix, in some cases it may be appropriate to initialize the entries as small random numbers rather than all zeros. Give one reason why this may be a good idea.

If all the weights are initialised to all zeros, then there will be 0 updates as the gradient descent algorithm will not update. This means that the weights will not change, and thus the algorithm will not learn.

In [ ]: