NAG Toolbox for MATLAB

f11bf

1 Purpose

f11bf is the third in a suite of three functions for the iterative solution of a real general (nonsymmetric) system of simultaneous linear equations (see Golub and Van Loan 1996). f11bf returns information about the computations during an iteration and/or after this has been completed. The first function of the suite, f11bd, is a setup function; the second function, f11be, is the iterative solver itself.

These three functions are suitable for the solution of large sparse general (nonsymmetric) systems of equations.

2 Syntax

```
[itn, stplhs, stprhs, anorm, sigmax, ifail] = f11bf(work, 'lwork', lwork)
```

3 Description

f11bf returns information about the solution process. It can be called either during a monitoring step of f11be or after f11be has completed its tasks. Calling f11bf at any other time will result in an error condition being raised.

For further information you should read the documentation for f11bd and f11be.

4 References

Golub G H and Van Loan C F 1996 *Matrix Computations* (3rd Edition) Johns Hopkins University Press, Baltimore

5 Parameters

5.1 Compulsory Input Parameters

1: **work**(**lwork**) – **double array**

The workspace **work** as returned by f11be (see also Sections 3 and 5 of the document for f11be).

5.2 Optional Input Parameters

1: **lwork – int32 scalar**

Default: The dimension of the array **work**.

Constraint: **lwork** ≥ 100.

Note: although the minimum value of **lwork** ensures the correct functioning of f11bf, a larger value is required by the iterative solver f11be (see also Section 5 of the document for f11bd).

5.3 Input Parameters Omitted from the MATLAB Interface

None.

5.4 Output Parameters

1: **itn – int32 scalar**

The number of iterations carried out by f11be.

2: **stplhs – double scalar**

The current value of the left-hand side of the termination criterion used by f11be.

3: **stprhs – double scalar**

The current value of the right-hand side of the termination criterion used by f11be.

4: **anorm – double scalar**

The norm $\|A\|_1$ or $\|A\|_\infty$ when it is used by the termination criterion in f11be, either when it has been supplied to f11bd or it has been estimated by f11be (see also Sections 3 and 5 of the document for f11bd); otherwise, **anorm** $= 0.0$ is returned.

5: **sigmax – double scalar**

The current estimate of the largest singular value $\sigma_1(\bar{A})$ of the preconditioned iteration matrix when it is used by the termination criterion in f11be, either when it has been supplied to f11bd or it has been estimated by f11be (see also Sections 3 and 5 of the document for f11bd); otherwise, **sigmax** $= 0.0$ is returned.

6: **ifail – int32 scalar**

0 unless the function detects an error (see Section 6).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

ifail $= -i$

If **ifail** $= -i$, parameter i had an illegal value on entry. The parameters are numbered as follows:

1: **itn**, 2: **stplhs**, 3: **stprhs**, 4: **anorm**, 5: **sigmax**, 6: **work**, 7: **lwork**, 8: **ifail**.

ifail $= 1$

f11bf has been called out of sequence. For example, the last call to f11be did not return **irevcm** $= 3$ or 4.

7 Accuracy

Not applicable.

8 Further Comments

None.

9 Example

```
method = 'BICGSTAB';
precon = 'P';
n = int32(8);
m = int32(1);
nnz = int32(24);
a = zeros(10000, 1);
a(1:24) = [2; -1; 1; 4; -3; 2; -7; 2; 3; -4; 5; 5; -1; 8; -3; -6; 5; 2; -
5; -1; 6; -1; 2; 3];
irow = zeros(10000, 1, 'int32');
irow(1:24) = [int32(1);
        int32(1);
```

```
        int32(1);
        int32(2);
        int32(2);
        int32(2);
        int32(3);
        int32(3);
        int32(4);
        int32(4);
        int32(4);
        int32(4);
        int32(5);
        int32(5);
        int32(5);
        int32(6);
        int32(6);
        int32(6);
        int32(7);
        int32(7);
        int32(7);
        int32(8);
        int32(8);
        int32(8)];
icol = zeros(10000, 1, 'int32');
icol(1:24) = [int32(1);
        int32(4);
        int32(8);
        int32(1);
        int32(2);
        int32(5);
        int32(3);
        int32(6);
        int32(1);
        int32(3);
        int32(4);
        int32(7);
        int32(2);
        int32(5);
        int32(7);
        int32(1);
        int32(3);
        int32(6);
        int32(3);
        int32(5);
        int32(7);
        int32(2);
        int32(6);
        int32(8)];
lfill = int32(0);
ipivp = zeros(8, 1, 'int32');
ipivq = zeros(8, 1, 'int32');
dtol = 0;
milu = 'N';
tol = 1e-08;
maxitn = int32(20);
anorm = 0;
sigmax = 0;
monit = int32(1);
lwork = int32(6000);
irevcm = int32(0);
u = zeros(8, 1);
v = [6;
     8;
     -9;
     46;
     17;
     21;
     22;
     34];
wgt = zeros(8, 1);
[a, irow, icol, ipivp, ipivq, istr, idiag, nnzc, npivm, ifail] = ...
```

```
    f11da(nnz, a, irow, icol, lfill, dtol, milu, ipivp, ipivq);
[lwreq, work, ifail] = ...
       f11bd(method, precon, n, m, tol, maxitn, anorm, sigmax, monit,
lwork, 'norm_p', '1');
while (irevcm ~= 4)
  [irevcm, u, v, work, ifail] = f11be(irevcm, u, v, wgt, work);

  if (irevcm == -1)
    [v, ifail] = f11xa('T', a(1:nnz), irow(1:nnz), icol(1:nnz), 'N', u);
  elseif (irevcm == 1)
    [v, ifail] = f11xa('N', a(1:nnz), irow(1:nnz), icol(1:nnz), 'N', u);
  elseif (irevcm == 2)
     [v, ifail] = f11db('N', a, irow, icol, ipivp, ipivq, istr, idiag,
'N', u);
    if (ifail ~= 0)
      irevcm = 6;
    end
  elseif (irevcm == 3)
    [itn, stplhs, stprhs, anorm, sigmax, ifail] = f11bf(work);
        fprintf('\nMonitoring  at  iteration  number  %d\nresidual  norm:
%14.4e\n', itn, stplhs);
    fprintf('\n   Solution Vector  Residual Vector\n');
    for i = 1:n
      fprintf('%+16.4e %+16.4e\n', u(i), v(i));
    end
  end
end
% Get information about the computation
[itn, stplhs, stprhs, anorm, sigmax, ifail] = f11bf(work);
fprintf('\nNumber of iterations for convergence: %d\n', itn);
fprintf('Residual norm:                             %14.4e\n', stplhs);
fprintf('Right-hand side of termination criteria: %14.4e\n', stprhs);
fprintf('i-norm of matrix a:                        %14.4e\n', anorm);
fprintf('\n   Solution Vector  Residual Vector\n');
for i = 1:n
  fprintf('%+16.4e %+16.4e\n', u(i), v(i));
end
```

```
Monitoring at iteration number 1
residual norm:     1.4059e+02

   Solution Vector  Residual Vector
     -4.5858e+00      +1.5256e+01
     +1.0154e+00      +2.6624e+01
     -2.2234e+00      -8.7498e+00
     +6.0097e+00      +1.8602e+01
     +1.3827e+00      +8.2821e+00
     -7.9070e+00      +2.0416e+01
     +4.4270e-01      +9.6094e+00
     +5.9248e+00      +3.3055e+01

Monitoring at iteration number 2
residual norm:     3.2742e+01

   Solution Vector  Residual Vector
     +4.1642e+00      -2.9585e+00
     +4.9370e+00      -5.5523e+00
     +4.8101e+00      +8.2070e-01
     +5.4324e+00      -1.6828e+01
     +5.8531e+00      +5.5975e-01
     +1.1925e+01      -1.9150e+00
     +8.4826e+00      +1.0081e+00
     +6.0625e+00      -3.1004e+00
Number of iterations for convergence: 3
Residual norm:                                  1.0474e-08
Right-hand side of termination criteria:     5.5900e-06
i-norm of matrix a:                             1.1000e+01
   Solution Vector  Residual Vector
+1.0000e+00      -1.3686e-09
     +2.0000e+00      -2.6364e-09
```

```
     +3.0000e+00      +2.2691e-10
     +4.0000e+00      -3.2517e-09
     +5.0000e+00      +6.3660e-10
     +6.0000e+00      -5.2943e-10
     +7.0000e+00      +9.6704e-10
     +8.0000e+00      -8.5717e-10
```