NAG Toolbox

nag_wav_1d_multi_inv (c09cd)

1 Purpose

nag_wav_1d_multi_inv (c09cd) computes the inverse one-dimensional multi-level discrete wavelet transform (DWT). This function reconstructs data from (possibly filtered or otherwise manipulated) wavelet transform coefficients calculated by nag_wav_1d_multi_fwd (c09cc) from an original set of data. The initialization function nag_wav_1d_init (c09aa) must be called first to set up the DWT options.

2 Syntax

```
[y, ifail] = nag_wav_1d_multi_inv(nwlinv, c, n, icomm, 'lenc', lenc)
[y, ifail] = c09cd(nwlinv, c, n, icomm, 'lenc', lenc)
```

3 Description

nag_wav_1d_multi_inv (c09cd) performs the inverse operation of nag_wav_1d_multi_fwd (c09cc). That is, given a set of wavelet coefficients, computed up to level n_{fwd} by nag_wav_1d_multi_fwd (c09cc) using a DWT as set up by the initialization function nag_wav_1d_init (c09aa), on a real data array of length n, nag_wav_1d_multi_inv (c09cd) will reconstruct the data array y_i, for $i = 1, 2, \ldots, n$, from which the coefficients were derived. If the original input dataset is level 0, then it is possible to terminate reconstruction at a higher level by specifying fewer than the number of levels used in the call to nag_wav_1d_multi_fwd (c09cc). This results in a partial reconstruction.

4 References

None.

5 Parameters

5.1 Compulsory Input Parameters

1: **nwlinv** – INTEGER

The number of levels to be used in the inverse multi-level transform. The number of levels must be less than or equal to n_{fwd}, which has the value of argument **nwl** as used in the computation of the wavelet coefficients using nag_wav_1d_multi_fwd (c09cc). The data will be reconstructed to level (**nwl** − **nwlinv**), where level 0 is the original input dataset provided to nag_wav_1d_multi_fwd (c09cc).

Constraint: $1 \leq$ **nwlinv** $\leq$ **nwl**, where **nwl** is the value used in a preceding call to nag_wav_1d_multi_fwd (c09cc).

2: **c**(**lenc**) – REAL (KIND=nag_wp) array

The coefficients of a multi-level wavelet transform of the dataset.

Let $q(i)$ be the number of coefficients (of each type) at level i, for $i = n_{\mathrm{fwd}}, n_{\mathrm{fwd}} - 1, \ldots, 1$. Then, setting $k_1 = q(n_{\mathrm{fwd}})$ and $k_{j+1} = k_j + q(n_{\mathrm{fwd}} - j + 1)$, for $j = 1, 2, \ldots, n_{\mathrm{fwd}}$, the coefficients are stored in **c** as follows:

c(i), for $i = 1, 2, \ldots, k_1$
Contains the level n_{fwd} approximation coefficients, $a_{n_{\mathrm{fwd}}}$.

c(i), for $i = k_1 + 1, \ldots, k_2$
Contains the level n_{fwd} detail coefficients $d_{n_{\text{fwd}}}$.

c(i), for $i = k_j + 1, \ldots, k_{j+1}$
Contains the level $n_{\text{fwd}} - j + 1$ detail coefficients, for $j = 2, 3, \ldots, n_{\text{fwd}}$.

The values $q(i)$, for $i = n_{\text{fwd}}, n_{\text{fwd}} - 1, \ldots, 1$, are contained in **dwtlev** which is produced as output by a preceding call to nag_wav_1d_multi_fwd (c09cc). See nag_wav_1d_multi_fwd (c09cc) for details.

3: **n** – INTEGER

n, the length of the data array, y, to be reconstructed. For a full reconstruction of **nwl** levels, where **nwl** is as supplied to nag_wav_1d_multi_fwd (c09cc), this must be the same as argument **n** used in the call to nag_wav_1d_multi_fwd (c09cc). For a partial reconstruction of **nwlinv** $<$ **nwl**, this must be equal to **dwtlev**(**nwlinv** $+ 2$), as returned from nag_wav_1d_multi_fwd (c09cc).

4: **icomm**(**100**) – INTEGER array

Contains details of the discrete wavelet transform and the problem dimension for the forward transform previously computed by nag_wav_1d_multi_fwd (c09cc).

5.2 Optional Input Parameters

1: **lenc** – INTEGER

Default: the dimension of the array **c**.

The dimension of the array **c**.

Constraint: **lenc** $\geq n_c$, where n_c is the total number of coefficients that correspond to a transform with **nwlinv** levels and is unchanged from the preceding call to nag_wav_1d_multi_fwd (c09cc).

5.3 Output Parameters

1: **y**(**n**) – REAL (KIND=nag_wp) array

The dataset reconstructed from the multi-level wavelet transform coefficients and the transformation options supplied to the initialization function nag_wav_1d_init (c09aa).

2: **ifail** – INTEGER

ifail $= 0$ unless the function detects an error (see Section 5).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

ifail $= 1$

Constraint: **nwlinv** ≥ 1.

On entry, **nwlinv** is larger than the number of levels computed by the preceding call to nag_wav_1d_multi_fwd (c09cc).

ifail $= 2$

lenc is too small.

ifail $= 4$

On entry, **n** is inconsistent with the value passed to the initialization function.

ifail $= 6$

Either the initialization function has not been called first or array **icomm** has been corrupted.

Either the initialization function was called with **wtrans** = 'S' or array **icomm** has been corrupted.

ifail $= -99$

An unexpected error has been triggered by this routine. Please contact NAG.

ifail $= -399$

Your licence key may have expired or may not have been installed correctly.

ifail $= -999$

Dynamic memory allocation failed.

7 Accuracy

The accuracy of the wavelet transform depends only on the floating-point operations used in the convolution and downsampling and should thus be close to ***machine precision***.

8 Further Comments

None.

9 Example

See Section 10 in nag_wav_1d_multi_fwd (c09cc).

9.1 Program Text

```
function c09cd_example

fprintf('c09cd example results\n\n');

n = nag_int(64);
wavnam = 'DB4';
mode = 'zero';
wtrans = 'Multilevel';
x = [ 6.5271; 6.512; 6.5016; 6.5237; 6.4625;
6.3496; 6.4025; 6.4035; 6.4407; 6.4746;
6.5095; 6.6551; 6.61; 6.5969; 6.6083;
6.652; 6.7113; 6.7227; 6.7196; 6.7649;
6.7794; 6.8037; 6.8308; 6.7712; 6.7067;
6.769; 6.7068; 6.7024; 6.6463; 6.6098;
6.59; 6.596; 6.5457; 6.547; 6.5797;
6.5895; 6.6275; 6.6795; 6.6598; 6.6925;
6.6873; 6.7223; 6.7205; 6.6843; 6.703;
6.647; 6.6008; 6.6061; 6.6097; 6.6485;
6.6394; 6.6571; 6.6357; 6.6224; 6.6073;
6.6075; 6.6379; 6.6294; 6.5906; 6.6258;
6.6369; 6.6515; 6.6826; 6.7042];
fprintf('\n Input Data:\n');
for i=1:8:double(n)
  fprintf('%8.4f ', x(i:i+8-1));
  fprintf('\n');
end
fprintf('\n');

% Query wavelet filter dimensions
[nwl, nf, nwc, icomm, ifail] = c09aa(wavnam, wtrans, mode, n);

if ifail == nag_int(0)
```

```
  % Perform Discrete Wavelet transform
  [c, dwtlev, icomm, ifail] = c09cc(x, nwc, nwl, icomm);

  if ifail == nag_int(0)
    fprintf(' Length of wavelet filter :             %10d\n', nf);
    fprintf(' Number of Levels :                     %10d\n\n', nwl);
    fprintf(' Number of coefficients in each level :\n     ');
    fprintf(' %8d', dwtlev);
    fprintf('\n');
    fprintf(' Total number of wavelet coefficients : %10d\n\n', nwc);
    fprintf(' Wavelet coefficients C : \n');
    for i=1:8:double(nwc)
      if i+8-1 <= numel(c)
        fprintf('%8.4f ', c(i:i+8-1));
      else
        fprintf('%8.4f ', c(i:numel(c)));
      end
      fprintf('\n');
    end
    fprintf('\n');

    % Reconstruct original data
    [y, ifail] = c09cd(nwl, c, n, icomm);

    if ifail == nag_int(0)
      fprintf('\n Reconstruction       Y : \n');
      for i=1:8:double(n)
        fprintf('%8.4f ', y(i:i+8-1));
        fprintf('\n');
      end
      fprintf('\n');
    end
  end
end
```

9.2 Program Results

```
     c09cd example results

 Input Data:
  6.5271   6.5120   6.5016   6.5237   6.4625   6.3496   6.4025   6.4035
  6.4407   6.4746   6.5095   6.6551   6.6100   6.5969   6.6083   6.6520
  6.7113   6.7227   6.7196   6.7649   6.7794   6.8037   6.8308   6.7712
  6.7067   6.7690   6.7068   6.7024   6.6463   6.6098   6.5900   6.5960
  6.5457   6.5470   6.5797   6.5895   6.6275   6.6795   6.6598   6.6925
  6.6873   6.7223   6.7205   6.6843   6.7030   6.6470   6.6008   6.6061
  6.6097   6.6485   6.6394   6.6571   6.6357   6.6224   6.6073   6.6075
  6.6379   6.6294   6.5906   6.6258   6.6369   6.6515   6.6826   6.7042

 Length of wavelet filter :                       8
 Number of Levels :                               6

 Number of coefficients in each level :
            7        7        8       10       14       21       35
 Total number of wavelet coefficients :         102

 Wavelet coefficients C :
  0.0000  -0.0227  -0.3446   2.7574 -10.1970  44.8800  15.9443   0.0010
 -0.4881 -10.2673  11.3258  -1.7469   2.0785  -0.7334  -0.0054  -0.1402
 -5.8980  -1.1527   5.5613   2.1352   0.3203  -0.4004   0.0010   0.5229
  0.5055  -2.7274  -0.0911  -0.2806  -0.3669   2.9467  -0.3799  -0.1552
  0.0218   0.0922   5.4626  -2.1620   0.5196  -0.0287  -0.0199   0.0920
 -0.0134  -0.1298  -5.5168   2.3105  -0.5383  -0.0155   0.3057   0.6186
 -1.5542   0.2682   0.1566   0.0030  -0.0152  -0.0589   0.0126   0.0063
  0.0171  -0.0268   0.0077  -0.0189   0.0207   0.0104  -0.3207  -0.6062
  1.6288  -0.2414  -0.0671   3.1657  -1.1462   0.2785   0.0523  -0.0030
 -0.0270  -0.0442   0.0090   0.0171  -0.0230  -0.0015   0.0213  -0.0402
 -0.0263  -0.0099   0.0021  -0.0250   0.0210  -0.0028  -0.0298  -0.0095
  0.0034   0.0281  -0.0188  -0.0002  -0.0173  -0.0076  -0.0014   0.0184
 -0.0318   0.0048   0.0047  -3.2555   1.1710  -0.2913
```

```
 Reconstruction       Y :
  6.5271   6.5120   6.5016   6.5237   6.4625   6.3496   6.4025   6.4035
  6.4407   6.4746   6.5095   6.6551   6.6100   6.5969   6.6083   6.6520
  6.7113   6.7227   6.7196   6.7649   6.7794   6.8037   6.8308   6.7712
  6.7067   6.7690   6.7068   6.7024   6.6463   6.6098   6.5900   6.5960
  6.5457   6.5470   6.5797   6.5895   6.6275   6.6795   6.6598   6.6925
  6.6873   6.7223   6.7205   6.6843   6.7030   6.6470   6.6008   6.6061
  6.6097   6.6485   6.6394   6.6571   6.6357   6.6224   6.6073   6.6075
  6.6379   6.6294   6.5906   6.6258   6.6369   6.6515   6.6826   6.7042
```