NAG Library Function Document

nag_imldwt_2d (c09edc)

1 Purpose

nag_imldwt_2d (c09edc) computes the inverse two-dimensional multi-level discrete wavelet transform (DWT). This function reconstructs data from (possibly filtered or otherwise manipulated) wavelet transform coefficients calculated by nag_mldwt_2d (c09ecc) from an original input matrix. The initialization function nag_wfilt_2d (c09abc) must be called first to set up the DWT options.

2 Specification

```
#include <nag.h>
#include <nagc09.h>
void nag_imldwt_2d (Integer nwlinv, Integer lenc, const double c[],
     Integer m, Integer n, double b[], Integer ldb, const Integer icomm[],
     NagError *fail)
```

3 Description

nag_imldwt_2d (c09edc) performs the inverse operation of nag_mldwt_2d (c09ecc). That is, given a set of wavelet coefficients, computed up to level n_{fwd} by nag_mldwt_2d (c09ecc) using a DWT as set up by the initialization function nag_wfilt_2d (c09abc), on a real matrix, A, nag_imldwt_2d (c09edc) will reconstruct A. The reconstructed matrix is referred to as B in the following since it will not be identical to A when the DWT coefficients have been filtered or otherwise manipulated prior to reconstruction. If the original input matrix 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_mldwt_2d (c09ecc). This results in a partial reconstruction.

4 References

None.

5 Arguments

1: **nwlinv** – Integer *Input*

On entry: 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_mldwt_2d (c09ecc). The data will be reconstructed to level (**nwl** – **nwlinv**), where level 0 is the original input dataset provided to nag_mldwt_2d (c09ecc).

Constraint: $1 \leq$ **nwlinv** $\leq$ **nwl**, where **nwl** is the value used in a preceding call to nag_mldwt_2d (c09ecc).

2: **lenc** – Integer *Input*

On entry: the dimension of the array **c**.

Constraint: **lenc** $\geq n_{\mathrm{ct}}$, where n_{ct} is the total number of coefficients that correspond to a transform with **nwlinv** levels and is unchanged from the preceding call to nag_mldwt_2d (c09ecc).

3: **c**[**lenc**] – const double *Input*

On entry: the coefficients of a multi-level wavelet transform of the original matrix, A, which may have been filtered or otherwise manipulated.

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 $k_{j+1} = k_j + q(n_{\mathrm{fwd}} - \lceil j/3 \rceil + 1)$, for $j = 1, 2, \ldots, 3n_{\mathrm{fwd}}$, the coefficients are stored in **c** as follows:

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

c$[i-1]$, for $i = k_j + 1, \ldots, k_{j+1}$
Contains the level $n_{\mathrm{fwd}} - \lceil j/3 \rceil + 1$ vertical, horizontal and diagonal coefficients. These are:

vertical coefficients if $j \bmod 3 = 1$;

horizontal coefficients if $j \bmod 3 = 2$;

diagonal coefficients if $j \bmod 3 = 0$,

for $j = 1, \ldots, 3n_{\mathrm{fwd}}$.

Note that the coefficients in **c** may be extracted according to level and type into two-dimensional arrays using nag_wav_2d_coeff_ext (c09eyc), and inserted using nag_wav_2d_coeff_ins (c09ezc).

4: **m** – Integer *Input*

On entry: the number of elements, m, in the first dimension of the reconstructed matrix B. For a full reconstruction of **nwl** levels, where **nwl** is as supplied to nag_mldwt_2d (c09ecc), this must be the same as argument **m** used in the call to nag_mldwt_2d (c09ecc). For a partial reconstruction of **nwlinv** $<$ **nwl** levels, this must be equal to **dwtlvm**[**nwlinv**], as returned from nag_mldwt_2d (c09ecc).

5: **n** – Integer *Input*

On entry: the number of elements, n, in the second dimension of the reconstructed matrix B. For a full reconstruction of **nwl** levels, where **nwl** is as supplied to nag_mldwt_3d (c09fcc), this must be the same as argument **n** used in the call to nag_mldwt_2d (c09ecc). For a partial reconstruction of **nwlinv** $<$ **nwl**, this must be equal to **dwtlvn**[**nwlinv**], as returned from nag_mldwt_2d (c09ecc).

6: **b**[**ldb** $\times$ **n**] – double *Output*

Note: the (i, j)th element of the matrix B is stored in **b**$[(j-1) \times$ **ldb** $+ i - 1]$.

On exit: the m by n reconstructed matrix, B, based on the input multi-level wavelet transform coefficients and the transform options supplied to the initialization function nag_wfilt_2d (c09abc).

7: **ldb** – Integer *Input*

On entry: the stride separating matrix row elements in the array **b**.

Constraint: **ldb** $\geq$ **m**.

8: **icomm**[**180**] – const Integer *Communication Array*

On entry: contains details of the discrete wavelet transform and the problem dimension as setup in the call to the initialization function nag_wfilt_2d (c09abc).

9: **fail** – NagError * *Input/Output*

The NAG error argument (see Section 2.7 in How to Use the NAG Library and its Documentation).

6 Error Indicators and Warnings

NE_ALLOC_FAIL

Dynamic memory allocation failed.
See Section 3.2.1.2 in How to Use the NAG Library and its Documentation for further information.

NE_BAD_PARAM

On entry, argument ⟨*value*⟩ had an illegal value.

NE_INITIALIZATION

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

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

NE_INT

On entry, **lenc** = ⟨*value*⟩.
Constraint: **lenc** $\geq$ ⟨*value*⟩, the total number of coefficients generated by the preceding call to nag_mldwt_2d (c09ecc).

On entry, **m** = ⟨*value*⟩.
Constraint: **m** $\geq$ ⟨*value*⟩, the number of coefficients in the first dimension at the required level of reconstruction.

On entry, **n** = ⟨*value*⟩.
Constraint: **n** $\geq$ ⟨*value*⟩, the number of coefficients in the second dimension at the required level of reconstruction.

On entry, **nwlinv** = ⟨*value*⟩.
Constraint: **nwlinv** ≥ 1.

NE_INT_2

On entry, **ldb** = ⟨*value*⟩ and **m** = ⟨*value*⟩.
Constraint: **ldb** $\geq$ **m**.

On entry, **nwlinv** = ⟨*value*⟩ and n_{fwd} = ⟨*value*⟩.
Constraint: **nwlinv** $\leq n_{\text{fwd}}$.

NE_INTERNAL_ERROR

An internal error has occurred in this function. Check the function call and any array sizes. If the call is correct then please contact NAG for assistance.

An unexpected error has been triggered by this function. Please contact NAG.
See Section 3.6.6 in How to Use the NAG Library and its Documentation for further information.

NE_NO_LICENCE

Your licence key may have expired or may not have been installed correctly.
See Section 3.6.5 in How to Use the NAG Library and its Documentation for further information.

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 Parallelism and Performance

nag_imldwt_2d (c09edc) is not threaded in any implementation.

9 Further Comments

None.

10 Example

See Section 10 in nag_mldwt_2d (c09ecc).