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 $i = n_{\text{fwd}}, n_{\text{fwd}} - 1, \ldots, 1$. Then, setting $k_1 = q(n_{\text{fwd}})$ and $k_{j+1} = k_j + q(n_{\text{fwd}} - \lceil j/3 \rceil + 1)$, for $j = 1, 2, \ldots, 3n_{\text{fwd}}$, 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, $a_{n_{\text{fwd}}}$.

c$[i-1]$, for $i = k_j + 1, \ldots, k_{j+1}$
Contains the level $n_{\text{fwd}} - \lceil j/3 \rceil + 1$ 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 $j = 1, \ldots, 3n_{\text{fwd}}$.

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 3.6 in the Essential Introduction).

6 Error Indicators and Warnings

NE_ALLOC_FAIL

Dynamic memory allocation failed.

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** ≥ ⟨*value*⟩, the total number of coefficients generated by the preceding call to nag_mldwt_2d (c09ecc).

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

On entry, **n** = ⟨*value*⟩.
Constraint: **n** ≥ ⟨*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** ≥ **m**.

On entry, **nwlinv** = ⟨*value*⟩ and n_{fwd} = ⟨*value*⟩.
Constraint: **nwlinv** ≤ n_{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.

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

Not applicable.

9 Further Comments

None.

10 Example

See Section 10 in nag_mldwt_2d (c09ecc).