

# NAG Library Function Document

## nag\_dtftr (f01vgc)

### 1 Purpose

nag\_dtftr (f01vgc) unpacks a real triangular matrix, stored in a Rectangular Full Packed (RFP) format array, to a full format array.

### 2 Specification

```
#include <nag.h>
#include <nagf01.h>

void nag_dtftr (Nag_OrderType order, Nag_RFP_Store transr,
               Nag_UploType uplo, Integer n, const double ar[], double a[],
               Integer pda, NagError *fail)
```

### 3 Description

nag\_dtftr (f01vgc) unpacks a real  $n$  by  $n$  triangular matrix  $A$ , stored in RFP format to conventional storage in a full format array. This function is intended for possible use in conjunction with functions from Chapters f06, f07 and f16 where some functions that use triangular matrices store them in RFP format. The RFP storage format is described in Section 3.3.3 in the f07 Chapter Introduction.

### 4 References

Gustavson F G, Waśniewski J, Dongarra J J and Langou J (2010) Rectangular full packed format for Cholesky's algorithm: factorization, solution, and inversion *ACM Trans. Math. Software* **37**, 2

### 5 Arguments

1: **order** – Nag\_OrderType *Input*

*On entry:* the **order** argument specifies the two-dimensional storage scheme being used, i.e., row-major ordering or column-major ordering. C language defined storage is specified by **order** = Nag\_RowMajor. See Section 2.3.1.3 in How to Use the NAG Library and its Documentation for a more detailed explanation of the use of this argument.

*Constraint:* **order** = Nag\_RowMajor or Nag\_ColMajor.

2: **transr** – Nag\_RFP\_Store *Input*

*On entry:* specifies whether the normal RFP representation of  $A$  or its transpose is stored.

**transr** = Nag\_RFP\_Normal

The RFP representation of the matrix  $A$  is stored.

**transr** = Nag\_RFP\_Trans

The transpose of the RFP representation of the matrix  $A$  is stored.

*Constraint:* **transr** = Nag\_RFP\_Normal or Nag\_RFP\_Trans.

3: **uplo** – Nag\_UploType *Input*

*On entry:* specifies whether  $A$  is upper or lower triangular.

**uplo** = Nag\_Upper

$A$  is upper triangular.

**uplo** = Nag\_Lower  
 A is lower triangular.

*Constraint:* **uplo** = Nag\_Upper or Nag\_Lower.

4: **n** – Integer *Input*

*On entry:*  $n$ , the order of the matrix  $A$ .

*Constraint:*  $n \geq 0$ .

5: **ar**[ $n \times (n + 1)/2$ ] – const double *Input*

*On entry:* the upper or lower  $n$  by  $n$  triangular matrix  $A$  (as specified by **uplo**) in either normal or transposed RFP format (as specified by **transr**). The storage format is described in Section 3.3.3 in the f07 Chapter Introduction.

6: **a**[*dim*] – double *Output*

**Note:** the dimension, *dim*, of the array **a** must be at least  $\mathbf{pda} \times \mathbf{n}$ .

*On exit:* the triangular matrix  $A$ .

If **order** = Nag\_ColMajor,  $A_{ij}$  is stored in  $\mathbf{a}[(j - 1) \times \mathbf{pda} + i - 1]$ .

If **order** = Nag\_RowMajor,  $A_{ij}$  is stored in  $\mathbf{a}[(i - 1) \times \mathbf{pda} + j - 1]$ .

If **uplo** = Nag\_Upper,  $A$  is upper triangular and the elements of the array below the diagonal are not set.

If **uplo** = Nag\_Lower,  $A$  is lower triangular and the elements of the array above the diagonal are not set.

7: **pda** – Integer *Input*

*On entry:* the stride separating row or column elements (depending on the value of **order**) of the matrix  $A$  in the array **a**.

*Constraint:*  $\mathbf{pda} \geq \max(1, \mathbf{n})$ .

8: **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 2.3.1.2 in How to Use the NAG Library and its Documentation for further information.

### NE\_BAD\_PARAM

On entry, argument  $\langle value \rangle$  had an illegal value.

### NE\_INT

On entry,  $\mathbf{n} = \langle value \rangle$ .

*Constraint:*  $\mathbf{n} \geq 0$ .

### NE\_INT\_2

On entry,  $\mathbf{pda} = \langle value \rangle$  and  $\mathbf{n} = \langle value \rangle$ .

*Constraint:*  $\mathbf{pda} \geq \max(1, \mathbf{n})$ .

**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 2.7.6 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 2.7.5 in How to Use the NAG Library and its Documentation for further information.

**7 Accuracy**

Not applicable.

**8 Parallelism and Performance**

nag\_dfttr (f01vgc) is not threaded in any implementation.

**9 Further Comments**

None.

**10 Example**

This example reads in a triangular matrix in RFP format and unpacks it to full format.

**10.1 Program Text**

```

/* nag_dfttr (f01vgc) Example Program.
 *
 * NAGPRODCODE Version.
 *
 * Copyright 2016 Numerical Algorithms Group.
 *
 * Mark 26, 2016.
 */

#include <stdio.h>
#include <nag.h>
#include <nag_stdlib.h>
#include <nagf01.h>
#include <nagx04.h>

int main(void)
{
    /* Scalars */
    Integer exit_status = 0, indent = 0, ncols = 80;
    Integer i, j, k, lar1, lar2, lenar, pda, pdar, q, n;
    /* Arrays */
    double *a = 0, *ar = 0;
    char nag_enum_transr[40], nag_enum_uplo[40], form[] = "%5.2f";
    /* Nag Types */
    Nag_MatrixType matrix;
    Nag_OrderType order;
    Nag_RFP_Store transr;
    Nag_UploType uplo;
    NagError fail;

#ifdef NAG_COLUMN_MAJOR
    order = Nag_ColMajor;
#define AR(I,J) ar[J*pdar + I]
#else

```

```

    order = Nag_RowMajor;
#define AR(I,J) ar[I*pdar + J]
#endif

    INIT_FAIL(fail);

    printf("nag_dtftr (f01vgc) Example Program Results\n\n");
    /* Skip heading in data file */
#ifdef _WIN32
    scanf_s("%*[\n] ");
    scanf_s("%" NAG_IFMT "%*[\n] ", &n);
    scanf_s("%39s ", nag_enum_transr, (unsigned)_countof(nag_enum_transr));
    scanf_s("%39s %*[\n] ", nag_enum_uplo,
            (unsigned)_countof(nag_enum_uplo));
#else
    scanf("%*[\n] ");
    scanf("%" NAG_IFMT "%*[\n] ", &n);
    scanf("%39s ", nag_enum_transr);
    scanf("%39s %*[\n] ", nag_enum_uplo);
#endif
    pda = n;
    lenar = (n * (n + 1)) / 2;
    if (!(a = NAG_ALLOC(pda * n, double)) || !(ar = NAG_ALLOC(lenar, double)))
    {
        printf("Allocation failure\n");
        exit_status = -1;
        goto END;
    }
    transr = (Nag_RFP_Store) nag_enum_name_to_value(nag_enum_transr);
    uplo = (Nag_UploType) nag_enum_name_to_value(nag_enum_uplo);

    /* Read an RFP matrix into array ar. */
    k = n / 2;
    q = n - k;
    if (transr == Nag_RFP_Normal) {
        lar1 = 2 * k + 1;
        lar2 = q;
    }
    else {
        lar1 = q;
        lar2 = 2 * k + 1;
    }
    if (order == Nag_RowMajor) {
        pdar = lar2;
    }
    else {
        pdar = lar1;
    }
    /* Read an RFP matrix into array AR. */
    for (i = 0; i < lar1; i++) {
#ifdef _WIN32
        for (j = 0; j < lar2; j++)
            scanf_s("%lf ", &AR(i, j));
#else
        for (j = 0; j < lar2; j++)
            scanf("%lf ", &AR(i, j));
#endif
    }

    /* Print the Rectangular Full Packed array
     * showing how the elements are arranged using
     * nag_gen_real_mat_print_comp (x04cbc).
     * Print real general matrix (comprehensive).
     */
    fflush(stdout);
    nag_gen_real_mat_print_comp(order, Nag_GeneralMatrix, Nag_NonUnitDiag, lar1,
                                lar2, ar, pdar, form,
                                "RFP Packed Array AR (graphical representation):",
                                Nag_IntegerLabels, NULL, Nag_IntegerLabels,
                                NULL, ncols, indent, NULL, &fail);
    if (fail.code != NE_NOERROR) {

```

```

    printf("Error from nag_gen_real_mat_print_comp (x04cbc).\n%s\n",
           fail.message);
    exit_status = 1;
}
printf("\n");

/* Copy real triangular matrix from Rectangular Full Packed format, ar,
 * to full format a using nag_dtftr (f01vgc).
 */
nag_dtftr(order, transr, uplo, n, ar, a, pda, &fail);
if (fail.code != NE_NOERROR) {
    printf("Error from nag_dtftr (f01vgc).\n%s\n", fail.message);
    exit_status = 1;
    goto END;
}

/* Print the unpacked array. */
matrix = (uplo == Nag_Upper ? Nag_UpperMatrix : Nag_LowerMatrix);

/* nag_gen_real_mat_print_comp (x04cbc).
 * Print real general matrix (comprehensive).
 */
fflush(stdout);
nag_gen_real_mat_print_comp(order, matrix, Nag_NonUnitDiag, n, n, a, pda,
                            form, "Unpacked Matrix A:", Nag_IntegerLabels,
                            NULL, Nag_IntegerLabels, NULL, ncols, indent,
                            NULL, &fail);
if (fail.code != NE_NOERROR) {
    printf("Error from nag_gen_real_mat_print_comp (x04cbc).\n%s\n",
           fail.message);
    exit_status = 1;
}
}

END:
NAG_FREE(a);
NAG_FREE(ar);
return exit_status;
}

```

## 10.2 Program Data

```

nag_dtftr (f01vgc) Example Program Data
4          : n
Nag_RFP_Normal Nag_Upper      : transr, uplo

1.30  1.40
2.30  2.40
3.30  3.40
1.10  4.40
1.20  2.20          : RFP Matrix ar[]

```

## 10.3 Program Results

```

nag_dtftr (f01vgc) Example Program Results

RFP Packed Array AR (graphical representation):
  1  2
1  1.30  1.40
2  2.30  2.40
3  3.30  3.40
4  1.10  4.40
5  1.20  2.20

Unpacked Matrix A:

```

	1	2	3	4
1	1.10	1.20	1.30	1.40
2		2.20	2.30	2.40
3			3.30	3.40
4				4.40

---