

NAG Toolbox

nag_rand_int_hypergeom (g05te)

1 Purpose

nag_rand_int_hypergeom (g05te) generates a vector of pseudorandom integers from the discrete hypergeometric distribution of the number of specified items in a sample of size l , taken from a population of size k with m specified items in it.

2 Syntax

```
[r, state, x, ifail] = nag_rand_int_hypergeom(mode, n, ns, np, m, r, state)
[r, state, x, ifail] = g05te(mode, n, ns, np, m, r, state)
```

3 Description

nag_rand_int_hypergeom (g05te) generates n integers x_i from a discrete hypergeometric distribution, where the probability of $x_i = I$ is

$$P(i = I) = \frac{l!m!(k-l)!(k-m)!}{I!(l-I)!(m-I)!(k-m-l+I)!k!} \quad \text{if } I = \max(0, m+l-k), \dots, \min(l, m),$$

$$P(i = I) = 0 \quad \text{otherwise.}$$

The variates can be generated with or without using a search table and index. If a search table is used then it is stored with the index in a reference vector and subsequent calls to nag_rand_int_hypergeom (g05te) with the same parameter values can then use this reference vector to generate further variates. The reference array is generated by a recurrence relation if $lm(k-l)(k-m) < 50k^3$, otherwise Stirling's approximation is used.

One of the initialization functions nag_rand_init_repeat (g05kf) (for a repeatable sequence if computed sequentially) or nag_rand_init_nonrepeat (g05kg) (for a non-repeatable sequence) must be called prior to the first call to nag_rand_int_hypergeom (g05te).

4 References

Knuth D E (1981) *The Art of Computer Programming (Volume 2)* (2nd Edition) Addison–Wesley

5 Parameters

5.1 Compulsory Input Parameters

1: **mode** – INTEGER

A code for selecting the operation to be performed by the function.

mode = 0

Set up reference vector only.

mode = 1

Generate variates using reference vector set up in a prior call to nag_rand_int_hypergeom (g05te).

mode = 2

Set up reference vector and generate variates.

mode = 3

Generate variates without using the reference vector.

Constraint: **mode** = 0, 1, 2 or 3.

2: **n** – INTEGER

n , the number of pseudorandom numbers to be generated.

Constraint: **n** \geq 0.

3: **ns** – INTEGER

l , the sample size of the hypergeometric distribution.

Constraint: $0 \leq \mathbf{ns} \leq \mathbf{np}$.

4: **np** – INTEGER

k , the population size of the hypergeometric distribution.

Constraint: **np** \geq 0.

5: **m** – INTEGER

m , the number of specified items of the hypergeometric distribution.

Constraint: $0 \leq \mathbf{m} \leq \mathbf{np}$.

6: **r**(lr) – REAL (KIND=nag_wp) array

lr , the dimension of the array, must satisfy the constraint

if **mode** = 0 or 2, lr must not be too small, but the limit is too complicated to specify;
if **mode** = 1, lr must remain unchanged from the previous call to nag_rand_int_hypergeom (g05te).

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If **mode** = 1, the reference vector from the previous call to nag_rand_int_hypergeom (g05te).

If **mode** = 3, **r** is not referenced.

7: **state**(:) – INTEGER array

Note: the actual argument supplied **must** be the array **state** supplied to the initialization routines nag_rand_init_repeat (g05kf) or nag_rand_init_nonrepeat (g05kg).

Contains information on the selected base generator and its current state.

5.2 Optional Input Parameters

None.

5.3 Output Parameters

1: **r**(lr) – REAL (KIND=nag_wp) array

If **mode** \neq 3, the reference vector.

2: **state**(:) – INTEGER array

Contains updated information on the state of the generator.

3: **x**(**n**) – INTEGER array

The pseudorandom numbers from the specified hypergeometric distribution.

4: **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: **mode** = 0, 1, 2 or 3.

ifail = 2

Constraint: **n** \geq 0.

ifail = 3

Constraint: $0 \leq \mathbf{ns} \leq \mathbf{np}$.

ifail = 4

Constraint: **np** \geq 0.

ifail = 5

Constraint: $0 \leq \mathbf{m} \leq \mathbf{np}$.

ifail = 6

On entry, some of the elements of the array **r** have been corrupted or have not been initialized.

The value of **ns**, **np** or **m** is not the same as when **r** was set up in a previous call with **mode** = 0 or 2.

ifail = 7

On entry, *lr* is too small when **mode** = 0 or 2.

ifail = 8

On entry, **state** vector has been corrupted or not initialized.

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

Not applicable.

8 Further Comments

None.

9 Example

The example program prints 20 pseudorandom integers from a hypergeometric distribution with $l = 500$, $m = 900$ and $n = 1000$, generated by a single call to `nag_rand_int_hypergeom` (g05te), after initialization by `nag_rand_init_repeat` (g05kf).

9.1 Program Text

```
function g05te_example

fprintf('g05te example results\n\n');

% Initialize the base generator to a repeatable sequence
seed = [nag_int(1762543)];
genid = nag_int(1);
subid = nag_int(1);
[state, ifail] = g05kf( ...
    genid, subid, seed);

% Number of variates
n = nag_int(20);

% Parameters
ns = nag_int(500);
np = nag_int(1000);
m = nag_int(900);

% Generate variates from hypergeometric distribution
mode = nag_int(2);
r = zeros(200, 1);
[r, state, x, ifail] = g05te( ...
    mode, n, ns, np, m, r, state);

disp('Variates');
disp(double(x));
```

9.2 Program Results

```
g05te example results

Variates
452
444
453
454
444
450
449
454
450
452
442
447
451
442
451
447
447
462
456
450
```
