NAG Toolbox for MATLAB

g05yb

1 Purpose

To generate multi-dimensional quasi-random sequences with a Gaussian or log-normal probability distribution.

2 Syntax

```
[quasi, iref, ifail] = g05yb(fcall, seq, lnorm, mean, std, iskip, iref,
'idim', idim)
```

3 Description

Low discrepancy (quasi-random) sequences are used in numerical integration, simulation and optimization. Like pseudo-random numbers they are uniformly distributed but they are not statistically independent, rather they are designed to give more even distribution in multidimensional space (uniformity). Therefore they are often more efficient than pseudo-random numbers in multidimensional Monte Carlo methods.

g05yb generates multi-dimensional quasi-random sequences with a Gaussian or log-normal probability distribution. The sequences are generated in pairs using the Box–Muller method. This means that an even number of dimensions are required by this function. If an odd number of dimensions are required then the extra dimension must be computed, but can then be ignored.

This function uses the sequences as described in g05ya.

4 References

Box G E P and Muller M E 1958 A note on the generation of random normal deviates *Ann. Math. Statist.* **29** 610–611

Brately P and Fox B L 1988 Algorithm 659: Implementing Sobol's Quasirandom Sequence Generator *ACM Trans. Math. Software* **14 (1)** 88–100

Fox B L 1986 Algorithm 647: Implementation and Relative Efficiency of Quasirandom Sequence Generators *ACM Trans. Math. Software* **12 (4)** 362–376

5 Parameters

5.1 Compulsory Input Parameters

1: **fcall – logical scalar**

The type of operation to perform.

fcall = **true**

The first call for initialization and there is no output via array **quasi**.

fcall = **false**

The sequence has already been initialized by a prior call to g05yb with **fcall** = **true**. Random numbers are output via array **quasi**.

2: **seq – string**

The type of sequence to generate.

seq = 'S'

A Sobol sequence.

seq = 'N'

A Neiderreiter sequence.

seq = 'F'

A Faure sequence.

Constraint: **seq** = 'S', 'N' or 'F'.

3: **lnorm – logical scalar**

Indicates whether to create Gaussian or log-normal variates.

lnorm = **true**

The variates are log-normal.

lnorm = **true**

The variates are Gaussian.

4: **mean**(**idim**) **– double array**

mean(k) is the mean of distribution for the kth dimension.

5: **std**(**idim**) **– double array**

std(k) is the standard deviation of the distribution for the kth dimension.

Constraint: **std**(i) > 0.0, for $i = 1, 2, \ldots,$ **idim**.

6: **iskip – int32 scalar**

The number of terms in the sequence to skip on initialization.

If **seq** = 'F', **iskip** is not referenced.

Constraint: if **seq** = 'N' or 'S' and **fcall** = **true**, **iskip** ≥ 0.

7: **iref**(**2000**) **– int32 array**

On entry/on exit: workspace used to contain information between calls to the function. The contents of this array should not be changed.

5.2 Optional Input Parameters

1: **idim – int32 scalar**

Default: The dimension of the arrays **mean**, **std**, **quasi**. (An error is raised if these dimensions are not equal.)

the number of dimensions required.

Constraint: $2 \leq$ **idim** ≤ 40 and **idim** must be even.

5.3 Input Parameters Omitted from the MATLAB Interface

None.

5.4 Output Parameters

1: **quasi**(**idim**) – **double array**

The random numbers, generated in pairs. That is, on the first call with **fcall** = **false**, **quasi**(k) contains the first quasi-random number for the kth dimension. On the next call **quasi**(k) contains the second quasi-random number for the kth dimension, ·

2: **iref**(**2000**) – **int32 array**

On entry/on exit: workspace used to contain information between calls to the function. The contents of this array should not be changed.

3: **ifail** – **int32 scalar**

0 unless the function detects an error (see Section 6).

6 Error Indicators and Warnings

Note: g05yb may return useful information for one or more of the following detected errors or warnings.

ifail = 1

On entry, **iskip** < 0 if **seq** = 'N' or 'S' and **fcall** = **true**,
or **idim** < 2,
or **idim** > 40,
or **seq** $\neq$ 'F', 'N' or 'S',
or **std**(i) ≤ 0.0, for some $i = 1, \ldots,$ **idim**.

ifail = 2

On entry, the array **iref** has not been correctly initialized.

ifail = 3

The value of **iskip** is too large.

ifail = 4

There have been too many calls in the sequence.

ifail = 5

An internal error has occurred within the functions. Please contact NAG.

7 Accuracy

Not applicable.

8 Further Comments

The maximum length of the generated sequences is $2^{29} - 1$, this should be adequate for practical purposes. For more information see g05ya.

9 Example

```
fcall = true;
seq = 'F';
lnorm = false;
mean = [2;
```

```
     2;
     2;
     2;
     2;
     2;
     2;
     2;
     2;
     2;
     2;
     2;
     2;
     2;
     2;
     2;
     2;
     2;
     2;
     2];
std = [1;
     1;
     1;
     1;
     1;
     1;
     1;
     1;
     1;
     1;
     1;
     1;
     1;
     1;
     1;
     1;
     1;
     1;
     1];
iskip = int32(134534030);
iref = zeros(2000, 1, 'int32');
[quasi, irefOut, ifail] = g05yb(fcall, seq, lnorm, mean, std, iskip,
iref)
```

```
quasi =
     0
     0
     0
     0
     0
     0
     0
     0
     0
     0
     0
     0
     0
     0
     0
     0
     0
     0
     0
irefOut =
     array elided
ifail =
           0
```