NAG Library Function Document

nag_tabulate_stats (g11bac)

1 Purpose

nag_tabulate_stats (g11bac) computes a table from a set of classification factors using a selected statistic.

2 Specification

```
#include <nag.h>
#include <nagg11.h>
void nag_tabulate_stats (Nag_TableStats stat, Nag_TableUpdate update,
     Nag_Weightstype weight, Integer n, Integer nfac, const Integer sf[],
     const Integer lfac[], const Integer factor[], Integer tdf,
     const double y[], const double wt[], double table[], Integer maxt,
     Integer *ncells, Integer *ndim, Integer idim[], Integer count[],
     double comm_ar[], NagError *fail)
```

3 Description

A dataset may include both classification variables and general variables. The classification variables, known as factors, take a small number of values known as levels. For example, the factor sex would have the levels male and female. These can be coded as 1 and 2 respectively. Given several factors, a multi-way table can be constructed such that each cell of the table represents one level from each factor. For example, the two factors sex and habitat, habitat having three levels: inner-city, suburban and rural, define the 2 by 3 contingency table:

Sex	**Habitat**		
	Inner-city	Suburban	Rural
Male			
Female			

For each cell statistics can be computed. If a third variable in the dataset was age, then for each cell the average age could be computed:

Sex	**Habitat**		
	Inner-city	Suburban	Rural
Male	25.5	30.3	35.6
Female	23.2	29.1	30.4

That is the average age for all observations for males living in rural areas is 35.6. Other statistics can also be computed: the number of observations, the total, the variance, the largest value and the smallest value.

nag_tabulate_stats (g11bac) computes a table for one of the selected statistics. The factors have to be coded with levels 1,2,... Weights can be used to eliminate values from the calculations, e.g., if they

represent 'missing values'. There is also the facility to update an existing table with the addition of new observations.

4 References

John J A and Quenouille M H (1977) *Experiments: Design and Analysis* Griffin

Kendall M G and Stuart A (1969) *The Advanced Theory of Statistics (Volume 1)* (3rd Edition) Griffin

West D H D (1979) Updating mean and variance estimates: An improved method *Comm. ACM* **22** 532–555

5 Arguments

1: **stat** – Nag_TableStats *Input*

On entry: indicates which statistic is to be computed for the table cells.

stat = Nag_TableStatsNObs
The number of observations for each cell.

stat = Nag_TableStatsTotal
The total for the variable in **y** for each cell.

stat = Nag_TableStatsAv
The average (mean) for the variable in **y** for each cell.

stat = Nag_TableStatsVar
The variance for the variable in **y** for each cell.

stat = Nag_TableStatsLarge
The largest value for the variable in **y** for each cell.

stat = Nag_TableStatsSmall
The smallest value for the variable in **y** for each cell.

Constraint: **stat** = Nag_TableStatsNObs, Nag_TableStatsTotal, Nag_TableStatsAv, Nag_TableStatsVar, Nag_TableStatsLarge or Nag_TableStatsSmall.

2: **update** – Nag_TableUpdate *Input*

On entry: indicates if an existing table is to be updated by further observation.

update = Nag_TableUpdateI
The table cells will be initialized to zero before tabulations take place.

update = Nag_TableUpdateU
The table input in **table** will be updated. The arguments **ncells**, **table**, **count** and **comm_ar** must remain unchanged from the previous call to nag_tabulate_stats (g11bac).

Constraint: **update** = Nag_TableUpdateI or Nag_TableUpdateU.

3: **weight** – Nag_Weightstype *Input*

On entry: indicates if weights are to be used.

weight = Nag_NoWeights
Weights are not used and unit weights are assumed.

weight = Nag_Weights or Nag_Weightsvar
Weights are used and must be supplied in **wt**. The only difference between **weight** = Nag_Weights and **weight** = Nag_Weightsvar is if the variance is computed.

weight = Nag_Weights
The divisor for the variance is the sum of the weights minus one and if **weight** = Nag_Weightsvar, the divisor is the number of observations with nonzero weights

minus one. The former is useful if the weights represent the frequency of the observed values.

If **stat** = Nag_TableStatsTotal or Nag_TableStatsAv, the weighted total or mean is computed respectively.

If **stat** = Nag_TableStatsNObs, Nag_TableStatsLarge or Nag_TableStatsSmall the only effect of weights is to eliminate values with zero weights from the computations.

Constraint: **weight** = Nag_NoWeights, Nag_Weightsvar or Nag_Weights.

4: **n** – Integer *Input*

On entry: the number of observations.

Constraint: $\mathbf{n} \geq 2$.

5: **nfac** – Integer *Input*

On entry: the number of classifying factors in **factor**.

Constraint: $\mathbf{nfac} \geq 1$.

6: **sf**[**nfac**] – const Integer *Input*

On entry: indicates which factors in **factor** are to be used in the tabulation.

If $\mathbf{sf}[i-1] > 0$ the ith factor in **factor** is included in the tabulation.

Note that if $\mathbf{sf}[i-1] \leq 0$ for $i = 1, 2, \ldots, \mathbf{nfac}$ then the statistic for the whole sample is calculated and returned in a 1 by 1 table.

7: **lfac**[**nfac**] – const Integer *Input*

On entry: the number of levels of the classifying factors in **factor**.

Constraint: if $\mathbf{sf}[i-1] > 0$, $\mathbf{lfac}[i-1] \geq 2$, for $i = 1, 2, \ldots, \mathbf{nfac}$.

8: **factor**[**n** × **tdf**] – const Integer *Input*

On entry: the **nfac** coded classification factors for the **n** observations.

Constraint: $1 \leq \mathbf{factor}[(i-1) \times \mathbf{tdf} + j - 1] \leq \mathbf{lfac}[j-1]$, for $i = 1, 2, \ldots, \mathbf{n}$ and $j = 1, 2, \ldots, \mathbf{nfac}$.

9: **tdf** – Integer *Input*

On entry: the stride separating matrix column elements in the array **factor**.

Constraint: $\mathbf{tdf} \geq \mathbf{nfac}$.

10: **y**[**n**] – const double *Input*

On entry: the variable to be tabulated.

If **stat** = Nag_TableStatsNObs, **y** is not referenced.

11: **wt**[**n**] – const double *Input*

On entry: if **weight** = Nag_Weights or Nag_Weightsvar, **wt** must contain the **n** weights. Otherwise **wt** is not referenced and can be set to null, `(double *)0`.

Constraint: if **weight** = Nag_Weights or Nag_Weightsvar, $\mathbf{wt}[i-1] \geq 0.0$, for $i = 1, 2, \ldots, \mathbf{n}$.

12: **table**[**maxt**] – double *Input/Output*

On entry: if **update** = Nag_TableUpdateU, **table** must be unchanged from the previous call to nag_tabulate_stats (g11bac), otherwise **table** need not be set.

On exit: the computed table. The **ncells** cells of the table are stored so that for any two factors the index relating to the factor referred to later in **lfac** and **factor** changes faster. For further details see Section 9.

13: **maxt** – Integer *Input*

On entry: the maximum size of the table to be computed.

Constraint: **maxt** $\geq$ product of the levels of the factors included in the tabulation.

14: **ncells** – Integer * *Input/Output*

On entry: if **update** = Nag_TableUpdateU, **ncells** must be unchanged from the previous call to nag_tabulate_stats (g11bac), otherwise **ncells** need not be set.

On exit: the number of cells in the table.

15: **ndim** – Integer * *Output*

On exit: the number of factors defining the table.

16: **idim**[**nfac**] – Integer *Output*

On exit: the first **ndim** elements contain the number of levels for the factors defining the table.

17: **count**[**maxt**] – Integer *Input/Output*

On entry: if **update** = Nag_TableUpdateU, **count** must be unchanged from the previous call to nag_tabulate_stats (g11bac), otherwise **count** need not be set.

On exit: a table containing the number of observations contributing to each cell of the table, stored identically to **table**. Note if **stat** = Nag_TableStatsNObs this is the same as is returned in **table**.

18: **comm_ar**[$*$] – double *Input/Output*

On entry: if **update** = Nag_TableUpdateU, **comm_ar** must be unchanged from the previous call to nag_tabulate_stats (g11bac), otherwise **comm_ar** need not be set.

On exit: if **stat** = Nag_TableStatsAv or Nag_TableStatsVar, the first **ncells** values hold the table containing the sum of the weights for the observations contributing to each cell, stored identically to **table**. If **stat** = Nag_TableStatsVar, then the second set of **ncells** values hold the table of cell means. Otherwise **comm_ar** is not referenced.

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

The NAG error argument (see Section 3.6 in the Essential Introduction).

6 Error Indicators and Warnings

NE_2_INT_ARG_LT

On entry, **tdf** = ⟨*value*⟩ while **nfac** = ⟨*value*⟩. These arguments must satisfy **tdf** $\geq$ **nfac**.

NE_2_INT_ARRAY_CONS

On entry, **sf**[⟨*value*⟩] = ⟨*value*⟩ while **lfac**[0] = ⟨*value*⟩.
Constraint: if **sf**[i] > 0, **lfac**[i] ≥ 2 for $i = 0, 1, \ldots,$ **nfac**.

NE_2D_1D_INT_ARRAYS_CONS

On entry, **factor**[(⟨*value*⟩) $\times$ **tdf** + ⟨*value*⟩] = ⟨*value*⟩ while **lfac**[0] = ⟨*value*⟩.
Constraint: **factor**[(i) $\times$ **tdf** + j] $\leq$ **lfac**[j], for $i = 0, 1, \ldots,$ **n** $- 1$ and $j = 0, 1, \ldots,$ **nfac** $- 1$.

NE_2D_INT_ARRAY_CONS

On entry, **factor**$[(\langle value\rangle) \times$ **tdf** $+ \langle value\rangle] = \langle value\rangle$.
Constraint: **factor**$[(i) \times$ **tdf** $+ j] \geq 1$, for $i = 0, 1, \ldots,$ **n** $- 1$ and $j = 0, 1, \ldots,$ **nfac** $- 1$.

NE_ALLOC_FAIL

Dynamic memory allocation failed.

NE_BAD_PARAM

On entry, argument **stat** had an illegal value.

On entry, argument **update** had an illegal value.

On entry, argument **weight** had an illegal value.

NE_G11BA_CHANGED

update = Nag_TableUpdateU and at least one of **ncells**, **table**, **comm_ar** or **count** have been changed since previous call to nag_tabulate_stats (g11bac).

NE_INT_ARG_LT

On entry, **n** $= \langle value\rangle$.
Constraint: **n** ≥ 2.

On entry, **nfac** $= \langle value\rangle$.
Constraint: **nfac** ≥ 1.

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.

NE_MAXT

The maximum size of the table to be computed, **maxt** is too small.

NE_REAL_ARRAY_CONS

On entry, **wt**$[\langle value\rangle] = \langle value\rangle$.
Constraint: if **weight** = Nag_Weights or Nag_Weightsvar, **wt**$[i] \geq 0.0$.

NE_VAR_DIV

stat = Nag_TableStatsVar and the divisor for the variance ≤ 0.0.

NE_WT_ARGS

The **wt** array argument must not be **NULL** when the **weight** argument indicates weights.

7 Accuracy

Only applicable when **stat** = Nag_TableStatsVar. In this case a one pass algorithm is used as described by West (1979).

8 Parallelism and Performance

Not applicable.

9 Further Comments

The tables created by nag_tabulate_stats (g11bac) and stored in **table**, **count** and, depending on **stat**, also in **comm_ar** are stored in the following way. Let there be n factors defining the table with factor k having l_k levels, then the cell defined by the levels $i_1, i_2, \ldots, i_n$ of the factors is stored in mth cell given by:

$$m = 1 + \sum_{k=1}^{n} \{(i_k - 1)c_k\},$$

where $c_j = \prod_{k=j+1}^{n} l_k$, for $j = 1, 2, \ldots, n-1$ and $c_n = 1$.

10 Example

The data, given by John and Quenouille (1977), is for a 3 by 6 factorial experiment in 3 blocks of 18 units. The data is input in the order: blocks, factor with 3 levels, factor with 6 levels, yield. The 3 by 6 table of treatment means for yield over blocks is computed and printed.

10.1 Program Text

```
/* nag_tabulate_stats (g11bac) Example Program.
 *
 * Copyright 2014 Numerical Algorithms Group.
 *
 * Mark 6a revised, 2001.
 */

#include <stdio.h>
#include <nag.h>
#include <nag_stdlib.h>
#include <nagg11.h>

int main(void)
{
  Integer         exit_status = 0, i, items, j, k, ltmax, maxt, n, ncells;
  Integer         ncol, ndim, nfac, nrow, tdf;
  Integer         *count = 0, *factor = 0, *idim = 0, *isf = 0, *lfac = 0;
  double          *comm_ar = 0, *table = 0, *wt = 0, *y = 0;
  char            nag_enum_arg[40];
  Nag_TableStats  stat;
  Nag_Weightstype weight;
  NagError        fail;

#define FACTOR(I, J) factor[((I) -1)*nfac + (J) -1]

  INIT_FAIL(fail);

  printf("nag_tabulate_stats (g11bac) Example Program Results\n");

  /* Skip heading in data file */
#ifdef _WIN32
  scanf_s("%*[^\n]");
#else
  scanf("%*[^\n]");
#endif
#ifdef _WIN32
  scanf_s("%39s", nag_enum_arg, _countof(nag_enum_arg));
#else
  scanf("%39s", nag_enum_arg);
#endif
  /* nag_enum_name_to_value (x04nac).
   * Converts NAG enum member name to value
   */
  stat = (Nag_TableStats) nag_enum_name_to_value(nag_enum_arg);
#ifdef _WIN32
  scanf_s("%39s", nag_enum_arg, _countof(nag_enum_arg));
#else
```

```
  scanf("%39s", nag_enum_arg);
#endif
  weight = (Nag_Weightstype) nag_enum_name_to_value(nag_enum_arg);
#ifdef _WIN32
  scanf_s("%"NAG_IFMT" %"NAG_IFMT" ", &n, &nfac);
#else
  scanf("%"NAG_IFMT" %"NAG_IFMT" ", &n, &nfac);
#endif

  ltmax = 18;
  maxt = ltmax;
  if (!(isf = NAG_ALLOC(nfac, Integer))
      || !(lfac = NAG_ALLOC(nfac, Integer))
      || !(idim = NAG_ALLOC(nfac, Integer))
      || !(factor = NAG_ALLOC(n*nfac, Integer))
      || !(count = NAG_ALLOC(maxt, Integer))
      || !(y = NAG_ALLOC(n, double))
      || !(wt = NAG_ALLOC(n, double))
      || !(table = NAG_ALLOC(maxt, double))
      || !(comm_ar = NAG_ALLOC(2*maxt, double)))
    {
      printf("Allocation failure\n");
      exit_status = -1;
      goto END;
    }

  if (weight == Nag_Weights || weight == Nag_Weightsvar)
    {
      for (i = 1; i <= n; ++i)
        {
          for (j = 1; j <= nfac; ++j)
#ifdef _WIN32
            scanf_s("%"NAG_IFMT"", &FACTOR(i, j));
#else
            scanf("%"NAG_IFMT"", &FACTOR(i, j));
#endif
#ifdef _WIN32
          scanf_s("%lf %lf", &y[i - 1], &wt[i - 1]);
#else
          scanf("%lf %lf", &y[i - 1], &wt[i - 1]);
#endif
        }
    }
  else
    {
      for (i = 1; i <= n; ++i)
        {
          for (j = 1; j <= nfac; ++j)
#ifdef _WIN32
            scanf_s("%"NAG_IFMT"", &FACTOR(i, j));
#else
            scanf("%"NAG_IFMT"", &FACTOR(i, j));
#endif
#ifdef _WIN32
          scanf_s("%lf", &y[i - 1]);
#else
          scanf("%lf", &y[i - 1]);
#endif
        }
    }
  for (j = 1; j <= nfac; ++j)
#ifdef _WIN32
    scanf_s("%"NAG_IFMT"", &lfac[j - 1]);
#else
    scanf("%"NAG_IFMT"", &lfac[j - 1]);
#endif
  for (j = 1; j <= nfac; ++j)
#ifdef _WIN32
    scanf_s("%"NAG_IFMT"", &isf[j - 1]);
#else
    scanf("%"NAG_IFMT"", &isf[j - 1]);
```

```
#endif
  tdf = 3;
  maxt = ltmax;

  /* nag_tabulate_stats (g11bac).
   * Computes multiway table from set of classification
   * factors using selected statistic
   */
  nag_tabulate_stats(stat, Nag_TableUpdateI, weight, n, nfac, isf,
                     lfac, factor, tdf, y, wt, table, maxt, &ncells, &ndim,
                     idim, count, comm_ar, &fail);
  if (fail.code != NE_NOERROR)
    {
      printf("Error from nag_tabulate_stats (g11bac).\n%s\n",
              fail.message);
      exit_status = 1;
      goto END;
    }
  printf("\n");
  printf("%s\n", "Table");
  printf("\n");
  ncol = idim[ndim - 1];
  nrow = ncells / ncol;
  k = 1;
  items = 0;
  for (i = 1; i <= nrow; ++i)
    {
      for (j = k, items = 1; j <= k + ncol - 1; ++j, items++)
        printf("%8.2f(%2"NAG_IFMT")%s", table[j - 1],
                count[j - 1], items%6?"":"\n");
      k += ncol;
    }

 END:
  NAG_FREE(isf);
  NAG_FREE(lfac);
  NAG_FREE(idim);
  NAG_FREE(factor);
  NAG_FREE(count);
  NAG_FREE(y);
  NAG_FREE(wt);
  NAG_FREE(table);
  NAG_FREE(comm_ar);

  return exit_status;
}
```

10.2 Program Data

```
nag_tabulate_stats (g11bac) Example Program Data

Nag_TableStatsAv  Nag_NoWeights  54 3

1 1 1 274
1 2 1 361
1 3 1 253
1 1 2 325
1 2 2 317
1 3 2 339
1 1 3 326
1 2 3 402
1 3 3 336
1 1 4 379
1 2 4 345
1 3 4 361
1 1 5 352
1 2 5 334
1 3 5 318
1 1 6 339
1 2 6 393
```

```
1 3 6 358
2 1 1 350
2 2 1 340
2 3 1 203
2 1 2 397
2 2 2 356
2 3 2 298
2 1 3 382
2 2 3 376
2 3 3 355
2 1 4 418
2 2 4 387
2 3 4 379
2 1 5 432
2 2 5 339
2 3 5 293
2 1 6 322
2 2 6 417
2 3 6 342
3 1 1  82
3 2 1 297
3 3 1 133
3 1 2 306
3 2 2 352
3 3 2 361
3 1 3 220
3 2 3 333
3 3 3 270
3 1 4 388
3 2 4 379
3 3 4 274
3 1 5 336
3 2 5 307
3 3 5 266
3 1 6 389
3 2 6 333
3 3 6 353

3 3 6
0 1 1
```

10.3 Program Results

```
nag_tabulate_stats (g11bac) Example Program Results

Table

  235.33( 3)  342.67( 3)  309.33( 3)  395.00( 3)  373.33( 3)  350.00( 3)
  332.67( 3)  341.67( 3)  370.33( 3)  370.33( 3)  326.67( 3)  381.00( 3)
  196.33( 3)  332.67( 3)  320.33( 3)  338.00( 3)  292.33( 3)  351.00( 3)
```