Operator INFO_FOILING

1 Goal

To carry out mathematical operations on structures of data of type function.

The following operations are currently available:

- the research of the maxima of a function,
- the calculation of the standard L_2 of a function,
- the standard deviation of a function,
- value RMS of a function,
- the value of the indicator of harmfulness of earthquake.

Product a structure of data `table`.

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2 Syntax

```
Fr        = INFO_FONCTION

    (  ♦  /  MAX =  _F (   ♦  FUNCTION = F,
    [function]
                       ◊  INTERVALLE = infor the third time,
       [L_R]
                    ),
           /  =_F NORMALIZES (♦  FUNCTION = F ,
           [function]
                       ),
           /  ECART_TYPE = (|dentic with the keyword RMS)
    [function]
           /  RMS =  _F (   ♦  FUNCTION  =  F,
    [function]
                       ◊  METHOD =  /  'TRAPEZOID',        [DEFECT]
                                   /  'SIMPSON',
                       ◊  INST_INIT =  tdeb,                 [R]
                       ◊  INST_FIN  =  tfin,                 [R]
                       ◊  CRITERION =  /  'RELATIVE',        [DEFECT]
                                   /  'ABSOLUTE',
                       ◊  PRECISION =  /  0,001,             [DEFECT]
                                   /  prec,                  [R]
                       ),


           /  NOCI_SEISME = _F (
                  ♦  /  FUNCTION  = F,                       [function]
                       ◊  OPTION =
                          |  'ALL',                          [DEFECT]
                          |  'MAXIMUM',
                             ◊  COEFF  =  / 0,               [DEFECT]
                                          /r1,               [R]
                             ◊  ◊  INST_INIT = tdeb,         [R]
                                ◊  INST_FIN  = tfin,         [R]
                                ◊  CRITERION   =/ 'RELATIVE', [DEFECT]
                                                 / 'ABSOLUTE',
                                ◊  PRECISION =   / 0,001,    [DEFECT]
                                                 / prec,     [R]
                          |  'INTE_ARIAS',
                             ◊  ◊  INST_INIT = tdeb,         [R]
                                ◊  INST_FIN  = tfin,         [R]
                                ◊  CRITERION =   / 'RELATIVE', [DEFECT]
                                                 / 'ABSOLUTE',
                                ◊  PRECISION =   / 0,001,    [DEFECT]
                                                 / prec,     [R]

                          |  'POUV_DEST' ,
                             ◊  COEFF  =/0,                  [DEFECT]
                                          / r1  ,            [R]
                             ◊  ◊  INST_INIT = tdeb,         [R]
                                ◊  INST_FIN  = tfin,         [R]
                                ◊  CRITERION =   / 'RELATIVE', [DEFECT]
                                                 / 'ABSOLUTE',
                                ◊  PRECISION =   / 0,001,    [DEFECT]
                                                 / prec,     [R]
                                ♦  GRAVITY   =   sea-green      [R]
```

```
                        |   'VITE_ABSO_CUMU',
                           ◊  ◊  INST_INIT = tdeb,          [R]
                              ◊  INST_FIN  = tfin,          [R]
                              ◊  CRITERION =  / 'RELATIVE', [DEFECT]
                                              / 'ABSOLUTE',
                              ◊  PRECISION =  / 0,001,      [DEFECT]
                                              / prec,         [R]

                        |   'DUREE_PHAS_FORT',
                           ◊  ◊  INST_INIT = tdeb,          [R]
                              ◊  INST_FIN  = tfin,          [R]
                              ◊  CRITERION =  / 'RELATIVE', [DEFECT]
                                              / 'ABSOLUTE',
                              ◊  PRECISION =  / 0,001,      [DEFECT]
                                              / prec,       [R]
                           ◊  BORNE_INF =   / 0.05,         [DEFECT]
                                            / binf,         [R]
                           ◊  BORNE_SUP =   / 0.95,         [DEFECT]
                                            / bsup,         [R]

                        |   ' ASA ' ,
                           ♦ FREQ_FOND    =  / FF
                           ♦ AMOR_REDUIT  =  / amndt          [R]

                           ◊  FREQ_FOND    =  / FF,         [R]
                           ◊  FREQ_PAS     =  / 0.01,       [DEFECT]
                                              / fPAS,       [R]
                           ◊  RATIO        =  / 0.4,        [DEFECT]
                                              / pp,         [R]
                           ◊  NORMALIZES         =  / 1. ,
        [DEFECT]
                                              / r2,         [R]

                        |   'INTE_SPEC' ,
                           ♦  AMOR_REDUIT  = amndt,            [R]
                           ◊  ◊  FREQ_INIT =  / 0.4,        [DEFECT]
                                              / fdeb,       [R]
                              ◊  FREQ_FIN  =  / 10. ,          [DEFECT]
                                              / end,    [R]
                              ◊  CRITERION  =/ 'RELATIVE', [DEFECT]
                                              / 'ABSOLUTE',
                              ◊  PRECISION =  / 0,001,      [DEFECT]
                                               / prec,      [R]
                           ◊  NORMALIZES         =  / 1. ,
        [DEFECT]
                                              / r2   ,      [R]
                        |      'ACCE_SUR_VITE',
                           ◊  COEFF        =  / 0,          [DEFECT]
                                              / r1   ,      [R]
                     /  SPEC_OSCI = sro  ,                  [function]
                        ◊  OPTION    =
                           |      'INTE_SPEC' ,             [DEFECT]
                           ♦  AMOR_REDUIT  = amndt,            [R]
                           ◊  NATURE       =  / 'ACCE',     [DEFECT]
                                               / 'QUICKLY',
                                              / 'DEPL',
                           ◊  NORMALIZES         =  / 1. ,
        [DEFECT]
```

```
                                        / r2   ,        [R]
                          ◊  ◊  FREQ_INIT =  / 0.4,      [DEFECT]
                                             / fdeb,     [R]
                             ◊  FREQ_FIN  =  / 10. ,        [DEFECT]
                                             / end,    [R]
                             ◊  CRITERION   =/ 'RELATIVE',[DEFECT]
                                             / 'ABSOLUTE',
                             ◊  PRECISION =  / 0,001,    [DEFECT]
                                              / prec,    [R]

                          ◊  FREQ         = lfre,        [l_R]
                          ◊  LIST_FREQ    = lfreq,       [listr8]
                             ),
    ◊  TITLE =   T,                                      [ L _K N ]
    ◊  INFORMATION =    /  1,
[DEFECT]
                   /  2,
    )
```

3 Opérandes

3.1 Keyword MAX

/ MAX =

Research of the X-coordinates where the maximum and the minimum are reached.
This operation is available on functions of nature function or tablecloth.

♦ FUNCTION = F

Name of the function or the functions of which one seeks the maxima.
If F is a function, the produced concept is a table whose parameters of access are:

FUNCTION , TYPE , it NOM_PARA function, it NOM_RESU function.

where one finds the name of the function respectively, MAXIMUM or MINIS, the X-coordinate of the maximum/minimum, the value of the maximum/minimum.
When several factors are provided, the table contains the max of the max, and the min of the min.

If F is a tablecloth, the produced concept is a table whose parameters of access are:

FUNCTION , TYPE , it NOM_PARA tablecloth, the name of the parameter of the functions (NOM_PARA_FONC), it NOM_RESU functions.

◊ INTERVAL =Inter

List of realities defining the terminals of Intervalles on which will be sought the min and max of the functions.
inter is composed of couples of realities of which the first corresponds on the terminal Inferior of the first|ntervalle, the second corresponds on the terminal superior of first Intervalle, and so on for the others Intervalles.
inter is thus composed of an even number of elements.
This keyword is not taken into account for the tablecloths.

3.2 Keyword NORMALIZES

This keyword makes it possible to follow convergence in accordance with the standard L_2 of a continuation of function f_N data in the form of a tablecloth. The table result comprises a line by function, the parameters of entry are NORMALIZES and FUNCTION.

♦ FUNCTION = F

Name of the tablecloth whose standard must be evaluated.

3.3 Keyword ECART_TYPE

/ ECART_TYPE =

The standard deviation of the function is calculated $f(t)$ who is defined by:

$$\sigma = \sqrt{\frac{1}{(t_{fin} - t_{deb})} \int_{t_{deb}}^{t_{fin}} (f(t) - \bar{f})^2 dt}$$ where $\bar{f}$ is the average on $[t_{deb}, t_{fin}]$

The keywords are Identic with those provided under the keyword factor RMS.

The produced concept is a table whose parameters of access are:

FUNCTION, METHOD, AVERAGE, INST_INIT, INST_FIN, ECART_TYPE.

3.4 Keyword RMS

/ RMS =

One calculates value RMS of the function $f(t)$ who is defined by:

$$RMS=\sqrt{\frac{1}{(t_{fin}-t_{deb})}\int_{t_{deb}}^{t_{fin}} f^2(t)\,dt}$$

♦ FUNCTION = F

Name of the function which one calculates value RMS.
Does not apply to the concepts of the type tablecloth.

◊ METHOD =

Name of METHOD that one uses to calculate the integral.

Two methods are available: method of 'TRAPEZOID' (by default) and method of 'SIMPSON'.

◊ INST_INIT = tdeb,
◊ INST_FIN = tfin,

Terminals Inférieure and higher of the interval of integration.
If these values are not indicated, points of discretization Inferior and superior (the relation of order being defined compared to the parameter in X-coordinate) are taken as limits interval of integration.

◊ PRECISION = / 0,001,
/ prec,

◊ CRITERION = / 'ABSOLUTE',
/ 'RELATIVE', [DEFECT]

One seeks a point of discretization of the function in one Intervalle defined by the absolute or relative position around a value of the parameter of the X-coordinates for which the function must be estimated:

- [inst (1-prec),Inst (1+prec)] if CRITERION = 'RELATIVE'
- [inst - prec,Inst + prec] if CRITERION = 'ABSOLUTE'

The produced concept is a table whose parameters of access are:

FUNCTION, METHOD, INST_INIT, INST_FIN, RMS.

3.5 Keyword NOCI_SEISME

/ NOCI_SEISME =

♦ / FUNCTION = F,
/ SPEC_OSCI = sro,

Name of the function (signal in acceleration $a(t)$) or of the tablecloth considered which must be defined in DEFI_FONCTION [U4.31.02] with NOM_RESU=' ACCE'.

If a tablecloth is considered, only the calculation of spectral radiant intensity is available.

◊ / OPTION =

Allows to choose one or more of the six Indices of harmfulness following:

| 'ALL'

give the whole of the six|ndices of harmfulness,

| 'MAXIMUM'

give the maximum of acceleration $a(t)$, speed $v(t)$ and of displacement (obtained by Integration)

$$PGA = \max_{t\in[t_i,t_f]} \left|a(t)\right| \quad , \quad PGV = \max_{t\in[t_i,t_f]} \left|v(t)\right| \quad , \quad PGD = \max_{t\in[t_i,t_f]} \left|x(t)\right|$$

| 'INTE_ARIAS'

give the intensity of Arias $I_A = \frac{\pi}{2g}\int_{t_i}^{t_f} a^2(t)\,dt$

where g is the acceleration of gravity. This value must be taught via the keyword GRAVITY.

| 'POUV_DEST'

give the destroying power $P_d = \frac{I_A}{\nu_0^c} = \frac{\pi^3}{2g}\int_{t_i}^{t_f} v^2(t)\,dt$

where g must be well informed by the keyword GRAVITY

| 'VITE_ABSO_CUMU'

give the cumulated absolute value speed $CAV = \int_{t_i}^{t_f} |a(t)|\,dt$

| 'DUREE_PHAS_FORT'

duration of strong phase (intensity of Arias being an increasing monotonous function):

Minimum duration $t_{\sup} - t_{inf}$ such as, for the terminals $b_{\inf}$, $b_{\sup}$:

$$b_{\inf} \times I_A \leqslant \frac{\pi}{2g}\int_{t_{inf}}^{t_{\sup}} a^2(f)\,dt \leqslant b_{\sup} \times I_A$$

where g must be well informed by the keyword GRAVITY.

The produced table contains t_{inf} under DEBUT_PHAS_FORT .

| 'ASA' (Spectral Average Acceleration)

This Indicator bases himself on the spectral pseudo-acceleration of the structure and depends on his fundamental frequency.

One damage, characterized by a fall of this Eigen frequency, is taken into account by the integration of spectral pseudo-accelerations $S_a(f,\eta)$ .sur a beach of frequencies:

$$ASA_R = \frac{1}{R f_0}\int_{(1-R)f_0}^{f_0} S_a(f,\eta)\,df$$

where R indicates the ratio defining the field of integration and η is reduced damping. The value of the ratio can be indicated by the user via the keyword RATIO. By default, one determines it ASA_{40} with R=0.4 and reduced damping $\eta = 0.05$. Mot_clé FREQ_PAS allows to define the step of integration. Spectral pseudo-acceleration will be normalized with NORMALIZES informed (by default 1.0).

| 'INTE_SPEC'

I spectral ntensity of Housner, between the frequencies f_{deb}, f_{fin} , $S_V(f,\eta)$ indicating the S pectre of Answer of Oscillator in pseudovelocities for reduced damping η :

$$I_H = \int_{f_{deb}}^{f_{fin}} \frac{S_V(f,\eta)}{f^2} df$$

| 'ACCE_SUR_VITE' report A_{max}/V_{max}

$$\text{ACCE\_SUR\_VITE} = \frac{\max_{t\in[t_i,t_f]} \{|a(t)|\}}{\max_{t\in[t_i,t_f]} \{|v(t)|\}}$$

According to the option, one must inform certain parameters, if one Indic step of option, by default, one calculates all them Indices thus IL is necessary all to inform. The method of integration is the method of 'TRAPEZOID'.

```
INST_INIT = tdeb,
INST_FIN = tfin,
```

Terminals Inférieure and higher of the time interval considered.

If these values are not indicated, points of discretization Inferior and superior (the relation of order being defined compared to the parameter in X-coordinate) are taken as limits interval.

```
PRECISION =  /  0,001,
             /  prec,

CRITERION =  /  'ABSOLUTE',
             /  'RELATIVE',          [DEFECT]
```

One seeks a point of discretization of the function in one Intervalle defined by the absolute or relative position around a value of the parameter of the X-coordinates for which the function must be estimated:

- [inst* (1-prec),Inst* (1+prec)] if CRITERION = 'RELATIVE'
- [inst - prec,Inst + prec] if CRITERION = 'ABSOLUTE'
- [freq* (1-prec), freq* (1+prec)] if CRITERION = 'RELATIVE'
- [freq - prec, freq + prec] if CRITERION = 'ABSOLUTE'

```
COEFF = r1
```

Constant of integration, by default 0. In the option 'MAXIMUM', one calculates speed and displacement by two Isuccessive ntégrations of damping, IL is thus necessary to inform COEFF if one does not want to take it by default.

```
FREQ_INIT = fdeb,
FREQ_FIN = fine,
```

Frequencies representing the two terminals of integration for the calculation of the spectral radiant intensity of Housner. Those must be understood between the extrema of the base of frequencies defining tablecloth SRO, if not poses a problem of interpolation. By defaults, these two frequencies are worth $0,4\,Hz$ and 10Hz.

```
AMOR_REDUIT = amndt
```

Reduced damping, for the calculation of the Spectrum of Answer of Oscillator in that of the spectral radiant intensity of Housner.

```
FREQ = lfre
```

fre = $(\Phi_{1,}...,\Phi_i,...)$. List of the frequencies.

```
LIST_FREQ = lfreq
```

List of the frequencies provided under a concept listr8.

```
= r2 NORMALIZES
```

The spectrum of oscillator will be normalized with the value r2 (value of pseudo-acceleration).

BORNE_INF = binf,
BORNE_SUP = bsup,

Terminals limiting the share of intensity Arias defining them Instants Initial and final of the strong phase (enters $(b_{\inf})\%$ and $(b_{\sup})\%$ of $(I_A)_{max}$) earthquake (one often takes 5% and 95%).

GRAVITY
Acceleration of Gravity. Its value depending on the units of the model, this keyword is obligatory for Indices INTE_ARIAS, POUV_DEST, DUREE_PHAS_FORT.

3.6 Operand TITLE

◊ TITLE = T

Title attache with the concept produced by this operator [U4.03.01].

3.7 Operand INFORMATION

◊ INFORMATION

If INFORMATION=2, one Imprime the function (IMPR_FONCTION format TABLE) in the file MESSAGE.

4 Examples

4.1 Research of the extrema of a function

4.1.1 Without Intervalle

```
A5=DEFI_FONCTION (
   NOM_RESU=' SIGM',
   NOM_PARA=' EPSI',
   VALE= (0,002, 400.0,
         0.003,500.0,
         0.0045,550.0,
         0.0065,580.0,
         0.008,590.0,
         0.01,600.0,
         0.02,600.0,
   ),
   PROL_DROITE=' CONSTANT',
   PROL_GAUCHE=' LINEAIRE',
)
= INFO_FONCTION (MAX=_F (FONCTION=A5),)

IMPR_TABLE (TABLE=tab)
```

give on the file 'RESULT' .

```
#
#ASTER  8.02.00 CONCEPT 1/24/2006 A 16:14 CALCULATES: 04 OF TYPE
#TABLE_SDASTER
 STANDARD FUNCTION     EPSI         SIGM
 A5       MINIS      2.00000E-03  4.00000E+02
 A5       MAXIMUM      1.00000E-02  6.00000E+02
```

```
 A5       MAXIMUM      2.00000E-02  6.00000E+02
```

4.1.2 With Intervalles

```
tab2 = INFO_FONCTION (MAX=_F (FONCTION=A5),
                           INTERVALLE= (0,002, 0,005,
                                        0.006,0,02),),)

IMPR_TABLE (TABLE=tab2)
```

give on the file 'RESULT' .

```
#
#ASTER  8.02.00 CONCEPT tab2 CALCULATES 1/24/2006 A 16:14: 04 OF TYPE
#TABLE_SDASTER
#Calcul of the extremas on A5 function on each Intervalle
 STANDARD FUNCTION INTERVALLE  EPSI_MIN    EPSI_MAX     EPSI         SIGM
 A5       MINIS       1      2.00000E-03 5.00000E-03  2.00000E-03 4.00000E+02
 A5       MAXIMUM       1      2.00000E-03 5.00000E-03  2.00000E-03 5.50000E+02
 A5       MINIS       2      6.00000E-03 2.00000E-03  6.00000E-03 5.80000E+02
 A5       MAXIMUM       2      6.00000E-03 2.00000E-03  1.00000E-02 6.00000E+02
 A5       MAXIMUM       2      6.00000E-03 2.00000E-03  2.00000E-02 6.00000E+02
```