

# OpenXM/Risa/Asir-Contrib

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OpenXM/Risa/Asir-Contrib User's Manual (日本語版)  
Edition 1.3.2-3 for OpenXM/Asir2000  
March 2017 (minor update on 2021 年3 月29 日)

by OpenXM Developing Team

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# 1 はじめに

数式処理システム `asir` は `OpenXM` プロトコル (Open message eXchange for Mathematics, <http://www.openxm.org>) をサポートしたサーバをコンポーネントとして利用できる。これらのサーバを呼ぶためのインタフェース関数はファイル `OpenXM/rc/asirrc` をロードすることによりシステムに読み込まれる。Risa/Asir (OpenXM 配布版) では起動時に自動的にこのファイルが読まれる。Risa/Asir (OpenXM 配布版) は、このマニュアルでは `OpenXM/Risa/Asir` と呼ぶ。このマニュアルでは `asir` 用のこれらの関数およびユーザ言語で書かれた数学関数およびユーティリティ関数を説明する。

HEAD branch に同期した最新版の `asir-contrib` マニュアルは <http://www.math.kobe-u.ac.jp/OpenXM/Current/doc/index-doc-ja.html> を参照。

`OpenXM` プロトコルの技術的詳細については、`$(OpenXM_HOME)/doc/OpenXM-specs` にあるファイル `openxm-jp.tex` を見て下さい。

それでは、あなたの計算機上で数学をお楽しみ下さい。

List of contributors:

- Maekawa, Masahide (Oct., 1999 – : CVS server)
- Noro, Masayuki (Jan., 1996 – : OpenXM Protocol OXRFC-100, `asir2000`)
- Ohara, Katsuyoshi (Jan., 1998 – : `ox-math`, `oxc` OXRFC-101)
- Takayama, Nobuki (Jan., 1996 – : OpenXM Protocol OXRFC-100, `kan/sm1`, `asir-contrib`)
- Tamura, Yasushi (Nov., 1998 – : OpenMath proxy, `tfb`)
- Fujimoto, Mitsushi (Windows)
- Iwane, Hidenao (Knapsack factorizer)
- Nakayama, Hiromasa (Gaussian elimination)
- Okutani, Yukio (Oct., 1999 – Feb., 2000 : matrix, diff, ...)
- Stillman, Mike (Macaulay 2 client and server)
- Tsai, Harrison (Macaulay 2 client and server)

この Contrib パッケージの著作権については, `OpenXM/Copyright` を見て下さい.  
有用だともいますが無保証です.

## 2 Asir/Contrib のロード方法.

OpenXM/rc/asirrc をロードすることにより Asir/Contrib の主な関数が利用可能となる. OpenXM/Risa/Asir ではASIR\_CONFIG 環境変数によりこのファイルを起動時に読みこんでいる. names.rr が Asir/Contrib のトップレベルのファイルである. このファイルよりその他のファイルが読み込まれている. 一部のパッケージはnames.rr からは読み込まれないので, 明示的に読み込む必要がある.

A sample of asirrc to use Asir/Contrib.

```
load("gr")$
load("primdec")$
load("katsura")$
load("bfct")$
load("names.rr")$
load("oxrfc103.rr")$
User_asirrc=which(getenv("HOME")+"/.asirrc")$
if (type(User_asirrc)!=0)
  if (!ctrl("quiet_mode")) print("Loading ~/.asirrc")$
  load(User_asirrc)$
else $
end$
```

### 3 Asir Contrib の関数名について

Asir Contrib には(1) 標準的な名前で定義された数学関数(`names.rr` および(2) Asir 標準関数以外の有用なライブラリ関数および(3) OpenXM サーバを asir から呼ぶための関数が含まれている.

Asir Contrib の関数名はモジュール化されているかまたは次の形をしている: カテゴリ名.関数名

標準的な数学関数は実体へのラッパーである. たとえば`sm1.hilbert` は OpenXM サーバ`sm1` の Hilbert 関数の計算関数を呼び出す関数である. 一方`poly_hilbert_polynomial` は Asir Contrib の Hilbert 関数を計算するための(1) に属する標準的な関数名である. 標準関数`poly_hilbert_polynomial` は, 現在`sm1.hilbert` を呼び出して Hilbert 関数を計算しているが, これは将来変更されるかもしれない. たとえば, Asir 言語で記述された有用なライブラリ関数集`commutativeRing.rr` が開発されて Hilbert 関数の計算関数`commutativeRing_hilbert_polynomial` が含まれるようになったら, 標準関数`poly_hilbert_polynomial` は, `commutativeRing_hilbert_polynomial` を呼び出して Hilbert 関数を計算するようになるかもしれない. したがって, ユーザプログラムは標準数学関数名を用いるのが望ましい.

標準数学関数名は, OpenXM project において, 全てのプロジェクトで共通の仕様を持つように努力している. たとえば, `kan/k0` も Asir Contrib と同様の標準数学関数名を持つ予定である. 現在実験的に数学関数のカテゴリ`complex` 複体(複素数でない) のマニュアルを `kan/k0`, `asir/contrib` で共通化を試みている.

以下の章は, 標準数学関数の解説をおこない, それからライブラリ関数, それから, OpenXM サーバのインタフェースの説明をおこなう.

## 4 Windows 版 Asir-contrib

Windows でも不完全ながら asir-contrib が動作する. 現在, 外部コンポーネント sm1 および, 外部コンポーネントを利用しない asir-contrib の関数が動作する. Cygwin 環境では外部コンポーネント sm1, phc が動作する. その他の外部コンポーネントは動作しない.

次の関数は Windows では動作しない. Windows での cygwin 環境では動作する場合がある.

- gnuplot.\*
- om.\*
- mathematica.\*
- phc.\*
- print\_dvi\_form
- print\_gif\_form
- print\_open\_math\_xml\_form
- print\_png\_form
- print\_xdvi\_form
- print\_xv\_form
- tigers\_xv\_form

## 5 基礎(標準函数)

### 5.0.1 base\_cancel

`base_cancel(S)`

: It simplifies *S* by canceling the common factors of denominators and numerators.

Example:

```
base_cancel([(x-1)/(x^2-1), (x-1)/(x^3-1)]);
```

### 5.0.2 base\_choose

`base_choose(L,M)`

: It returns the list of the order *M* subsets of *L*.

Example:

```
base_choose([1,2,3],2);
```

It outputs all the order 2 subsets of the set  $\{1, 2, 3\}$

### 5.0.3 base\_f\_definedp

`base_f_definedp(Func)`

: returns 1 if the function *Func* is defined.

### 5.0.4 base\_flatten

`base_flatten(S)`

: It flattens a nested list *S*.

Example:

```
base_flatten([[1,2,3],4]);
```

### 5.0.5 base\_intersection

`base_intersection(A,B)`

: It returns the intersection of *A* and *B* as a set.

Example:

```
base_intersection([1,2,3],[2,3,5,[6,5]]);
```

### 5.0.6 base\_is\_asir2018

`base_is_asir2018()`

: returns 1 if the system is asir2018.

### 5.0.7 base\_is\_equal

`base_is_equal(L1,L2)`

: returns 1 if the objects *L1* and *L2* are equal else return 0

### 5.0.8 base\_makelist

`base_makelist(Obj,K,B,T)`

: `base_makelist` generate a list from `Obj` where `K` runs in `[B,T]`. Options are `qt=1` (keep quote data), `step` (step size). When `B` is a list, `T` is ignored and `K` runs in `B`.

Example 0:

```
base_makelist(k^2,k,1,10);
```

Example 1:

```
map(print_input_form,base_makelist(quote(x^2),x,1,10 | qt=1, step=0.5))
```

Example 2:

```
base_makelist(quote("the "+k),k,["cat","dog"],0);
```

### 5.0.9 base\_memberq

`base_memberq(A,S)`

: It returns 1 if `A` is a member of the set `S` else returns 0.

Example:

```
base_memberq(2,[1,2,3]);
```

### 5.0.10 base\_permutation

`base_permutation(L)`

: It outputs all permutations of `L`. BUG; it uses a slow algorithm.

Example:

```
base_permutation([1,2,3,4]);
```

### 5.0.11 base\_position

`base_position(A,S)`

: It returns the position of `A` in `S`.

Example:

```
base_position("cat",["dog","cat","monkey"]);
```

### 5.0.12 base\_preplace

`base_preplace(S,Rule)`

: It rewrites `S` by using the rule `Rule`. `psubst` is used instead of `subst`. The replacement is not performed for function arguments.

Example:

```
base_preplace(exp(x)+x^2,[[x,a+1],[exp(x),b]]);
```

`x` is replaced by `a+1` and `exp(x)` is replaced by `b` in `exp(x)+x^2`.

### 5.0.13 base\_product

`base_product(Obj, K, B, T)`

: `base_product` returns the product of `Obj` where `K` runs in `[B,T]`. Options are `qt=1` (keep quote data), `step` (step size). When `B` is a list, `K` runs in `B` and `T` is ignored.

Example 0:

```
base_product(k^2,k,1,10);
```

Example 1:

```
base_product(quote(x^2),x,1,10 | qt=1, step=0.5);
```

Example 2:

```
base_product(quote(x^2),x,[a,b,c],0 | qt=1);
```

### 5.0.14 base\_prune

`base_prune(A, S)`

: It returns a list in which `A` is removed from `S`.

Example:

```
base_prune("cat",["dog","cat","monkey"]);
```

### 5.0.15 base\_rebuild\_opt

`base_rebuild_opt(Opt)`

: It rebuilt the option list `Opt`

Example:

```
base_rebuild_opt([[key1,1],[key2,3]] | remove_keys=["key2"]);
```

it returns `[[key1,1]]`

### 5.0.16 base\_replace

`base_replace(S, Rule)`

: It rewrites `S` by using the rule `Rule`

Example:

```
base_replace(x^2+y^2,[[x,a+1],[y,b]]);
```

`x` is replaced by `a+1` and `y` is replaced by `b` in `x^2+y^2`.

### 5.0.17 base\_replace\_n

`base_replace_n(S, Rule)`

: It rewrites `S` by using the rule `Rule`. It is used only for specializing variables to numbers and faster than `base_replace`.

Example:

```
base_replace_n(x^2+y^2,[[x,1/2],[y,2.0+3*@i]]);
```

`x` is replaced by `1/2` and `y` is replaced by `2.0+3*i` in `x^2+y^2`.

**5.0.18 base\_set\_minus**

`base_set_minus(A,B)`  
                   :  $A \setminus B$

Example:

```
base_set_minus([1,2,3],[3,4,5]);
```

**5.0.19 base\_set\_union**

`base_set_union(A,B)`  
                   :  $A \cup B$

Example:

```
base_set_union([1,2,3],[3,4,5]);
```

**5.0.20 base\_subsetq**

`base_subsetq(A,B)`  
                   : if  $A \subseteq B$ , then it returns 1 else 0.

Example:

```
base_subsetq([1,2],[1,2,3,4,5]);
```

**5.0.21 base\_subsets\_of\_size**

`base_subsets_of_size(K,S)`  
                   : It outputs all subsets of  $S$  of the size  $K$ . BUG; it uses a slow algorithm. Do not input a large  $S$ .

Example:

```
base_subsets_of_size(2,[3,5,3,2]);
```

**5.0.22 base\_sum**

`base_sum(Obj,K,B,T)`  
                   : `base_sum` returns the sum of `Obj` where  $K$  runs in  $[B,T]$ . Options are `qt=1` (keep quote data), `step` (step size). When  $B$  is a list,  $K$  runs in  $B$  and  $T$  is ignored. When  $K$  is 0, then `Obj` is assumed to be a list or vector and `Obj[B]+...+Obj[T]` is returned.

Example 0:

```
base_sum(k^2,k,1,10);
```

Example 1:

```
base_sum(quote(x^2),x,1,10 | qt=1, step=0.5);
```

Example 2:

```
base_sum(quote(x^2),x,[a,b,c],0 | qt=1);
```

### 5.0.23 base\_var\_list

`base_var_list(Name,B,T)`

: `base_var_list` generate a list of variables `Name+Index` where `Index` runs on `[B,T]`.

Example 0:

```
base_var_list(x,0,10);
```

Example 1:

```
base_var_list(x,1,4 | d = 1);
```

Options are `d=1` (add `d` before the name).

## 6 数(標準数学函数)

### 6.0.1 number\_abs

`number_abs( $X$ )`  
:

Example:

```
number_abs(-3);
```

### 6.0.2 number\_ceiling

`number_ceiling( $X$ )`  
:

Example:

```
number_abs(1.5);
```

### 6.0.3 number\_eval

`number_eval( $X$ )`  
:

Example:

```
number_eval([1/10^10,@pi,exp(1)]);
```

### 6.0.4 number\_factor

`number_factor( $X$ )`  
: It factors the given integer  $X$ .

Example:

```
number_factor(20);
```

### 6.0.5 number\_float\_to\_rational

`number_float_to_rational( $X$ )`  
:

Example:

```
number_float_to_rational(1.5234);
number_float_to_rational(1.5234 | prec=14);
```

### 6.0.6 number\_floor

`number_floor( $X$ )`  
:

Example:

```
number_floor(1.5);
```

**6.0.7 number\_imaginary\_part**`number_imaginary_part(X)`

:

Example:

`number_imaginary_part(1+2*@i);`**6.0.8 number\_is\_integer**`number_is_integer(X)`

:

Example:

`number_is_integer(2/3);`**6.0.9 number\_real\_part**`number_real_part(X)`

:

Example:

`number_real_part(1+2*@i);`

## 7 微積分(標準数学函数)

## 8 級数(標準数学函数)

## 9 特殊函数(標準数学函数)

まだ書いてない.

## 10 行列(標準数学函数)

### 10.0.1 matrix\_adjugate

`matrix_adjugate(M)`  
: It generates the adjugate matrix of the matrix *M*.

Example:

```
matrix_adjugate(matrix_list_to_matrix([[a,b],[c,d]]));
```

### 10.0.2 matrix\_clone

`matrix_clone(M)`  
: It generates the clone of the matrix *M*.

Example:

```
matrix_clone(matrix_list_to_matrix([[1,1],[0,1]]));
```

### 10.0.3 matrix\_det

`matrix_det(M)`  
: It returns the determinant of the matrix *M*.

Example:

```
poly_factor(matrix_det([[1,x,x^2],[1,y,y^2],[1,z,z^2]]));
```

### 10.0.4 matrix\_diagonal\_matrix

`matrix_diagonal_matrix(L)`  
: It returns the diagonal matrix with diagonal entries *L*.

Example:

```
matrix_diagonal_matrix([1,2,3]);
```

References:

```
matrix_list_to_matrix
```

### 10.0.5 matrix\_eigenvalues

`matrix_eigenvalues(M)`  
: It returns the eigenvalues of the matrix *M*. if the option num=1, it returns the numerical approximate eigenvalues.

Example:

```
matrix_eigenvalues([[x,1],[0,y]]);
```

### 10.0.6 matrix\_gauge\_transformation

`matrix_gauge_transformation(M,T,V)`  
: It returns  $T^{-1} M T - T^{-1} dT/dV$

Example:

```
matrix_gauge_transformation([[0,x],[1,x]],[[x,0],[0,1]],x);
```

### 10.0.7 matrix\_identity\_matrix

`matrix_identity_matrix(N)`

: It returns the identity matrix of the size *N*.

Example:

```
matrix_identity_matrix(5);
```

References:

`matrix_diagonal_matrix`

### 10.0.8 matrix\_ij

`matrix_ij(N, II, JJ)`

: It returns the matrix for exchanging *II*-th row(col) and *JJ*-th row(col).

Example:

```
matrix_ij(4,0,2);
```

### 10.0.9 matrix\_image

`matrix_image(M)`

: It computes the image of *M*. Redundant vectors are removed.

Example:

```
matrix_image([[1,2,3],[2,4,6],[1,0,0]]);
```

References:

`matrix_kernel`

### 10.0.10 matrix\_inner\_product

`matrix_inner_product(A, B)`

: It returns the inner product of two vectors *A* and *B*.

Example:

```
matrix_inner_product([1,2],[x,y]);
```

### 10.0.11 matrix\_inverse

`matrix_inverse(M)`

: It returns the inverse of the matrix *M*.

Example:

```
matrix_inverse([[1,2],[0,1]]);
```

### 10.0.12 matrix\_inverse\_singular

`matrix_inverse_singular(Mat)`

: It returns a quasi-inverse matrix of *Mat* when it has 0-row and 0-column.

Example:

```
matrix_inverse_singular(newmat(3,3,[[1,0,2],[0,0,0],[3,0,4]]));
```

**10.0.13 matrix\_kernel****matrix\_kernel(*M*)**: It returns the basis of the kernel of the matrix *M*.

Example:

```
matrix_kernel([[1,1,1,1],[0,1,3,4]]);
```

**10.0.14 matrix\_list\_to\_matrix****matrix\_list\_to\_matrix(*M*)**: It translates the list *M* to a matrix.

Example:

```
print_xdvi_form(matrix_list_to_matrix([[1,1],[0,2]]));
```

References:

```
matrix_matrix_to_list
```

**10.0.15 matrix\_matrix\_to\_list****matrix\_matrix\_to\_list(*M*)**: It translates the matrix *M* to a list.

References:

```
matrix_list_to_matrix
```

**10.0.16 matrix\_poly\_to\_matrix****matrix\_poly\_to\_matrix(*Poly*,*Rule*)**: Replace variables in the polynomial *Poly* by matrices in the *Rule*.

Example:

```
matrix_poly_to_matrix(x^2-1,[[x,newmat(2,2,[[2,0],[0,3]])]]);
```

**10.0.17 matrix\_rank****matrix\_rank(*M*)**: It returns the rank of the matrix *M*.

Example:

```
matrix_rank([[1,1,1,1],[0,1,3,4]]);
```

**10.0.18 matrix\_solve\_linear****matrix\_solve\_linear(*M*,*X*,*B*)**: It solves the system of linear equations  $M X = B$ 

Example:

```
matrix_solve_linear([[1,2],[0,1]],[x,y],[1,2]);
```

**10.0.19 matrix\_submatrix**`matrix_submatrix( $M$ ,  $Ind$ )`: It returns the submatrix of  $M$  defined by the index set  $Ind$ .

Example:

`matrix_submatrix([[0,1],[2,3],[4,5]],[1,2]);`**10.0.20 matrix\_transpose**`matrix_transpose( $M$ )`: It returns the transpose of the matrix  $M$ .

References:

`matrix_list_to_matrix`

## 11 Graphic(標準数学函数)

まだ書いてない.

## 12 表示(標準数学函数)

### 12.0.1 print\_dvi\_form

`print_dvi_form(S)`  
: It outputs  $S$  to a dvi file.

Example:

```
print_dvi_form(x^2-1);
```

References:

```
print_xdvi_form , print_tex_form
```

### 12.0.2 print\_em

`print_em(S)`  
: It outputs  $S$  by a font to emphasize it.

Example:

```
print_em(x^2-1);
```

### 12.0.3 print\_gif\_form

`print_gif_form(S)`  
: It outputs  $S$  to a file of the gif format.

`print_gif_form(S | table=key0)`  
: This function allows optional variables *table*

Example:

```
print_gif_form(newmat(2,2,[[x^2,x],[y^2-1,x/(x-1)]]));
```

References:

```
print_tex_form
```

### 12.0.4 print\_input\_form

`print_input_form(S)`  
: It transforms  $S$  to a string which can be parsed by asir.

Example:

```
print_input_form(quote(x^3-1));
```

### 12.0.5 print\_open\_math\_tfb\_form

`print_open_math_tfb_form(S)`  
: It transforms  $S$  to a tfb format of OpenMath XML.

Description:

It is experimental. You need to load `taka_print_tfb.rr` to call it.

Example:

```
print_open_math_tfb_form(quote(f(x,1/(y+1))+2));
```

### 12.0.6 print\_open\_math\_xml\_form

`print_open_math_xml_form(S)`

: It transforms  $S$  to a string which is compliant to OpenMath(1999).

Example:

```
print_open_math_xml_form(x^3-1);
```

References:

[www.openmath.org](http://www.openmath.org)

### 12.0.7 print\_output

`print_output(Obj)`

: It outputs the object  $Obj$  to a file. If the optional variable  $file$  is set, then it outputs the  $Obj$  to the specified file, else it outputs it to "asir\_output.tmp.txt". If the optional variable  $mode$  is set to "w", then the file is newly created. If the optional variable is not set, the  $Obj$  is appended to the file.

`print_output(Obj | file=key0,mode=key1)`

: This function allows optional variables  $file$ ,  $mode$

Example:

```
print_output("Hello"|file="test.txt");
```

References:

`glib_tops` , ( , )

### 12.0.8 print\_ox\_rfc100\_xml\_form

`print_ox_rfc100_xml_form(S)`

: It transforms  $S$  to a string which is compliant to OpenXM RFC 100.

Example:

```
print_ox_rfc100_xml_form(x^3-1);
```

References:

[www.openxm.org](http://www.openxm.org)

### 12.0.9 print\_pdf\_form

`print_pdf_form(S)`

: It transforms  $S$  to a pdf file and previews the file.

Example 0:

```
print_pdf_form(newmat(2,2,[[x^2,x],[y^2-1,x/(x-1)]]));
```

Example 1:

```
print_pdf_form(poly_factor(x^10-1));
```

References:

`print_tex_form` , `print_xdvi_form`

**12.0.10 print\_png\_form**`print_png_form(S)`: It transforms  $S$  to a file of the format png. dvi2png should be installed.

Example:

`print_png_form(x^3-1);`

References:

`print_tex_form`**12.0.11 print\_terminal\_form**`print_terminal_form(S)`: It transforms  $S$  to the terminal form???**12.0.12 print\_tex\_form**`print_tex_form(S)`: It transforms  $S$  to a string of the LaTeX format.`print_tex_form(S | table=key0,raw=key1)`: This function allows optional variables *table*, *raw*

Description:

The global variable `Print_tex_form_fraction_format` takes the values "auto", "frac", or "/". The global variable `Print_tex_form_no_automatic_subscript` takes the values 0 or 1. BUG; A large input  $S$  cannot be translated.

Example:

`print_tex_form(x*dx+1 | table=[["dx","\partial_x"]]);`

The optional variable *table* is used to give a translation table of asir symbols and tex symbols. when `AMSTeX = 1`, "begin pmatrix" and "end pmatrix" will be used to output matrix.

References:

`print_xdvi_form`**12.0.13 print\_tfb\_form**`print_tfb_form(S)`: It transforms  $S$  to the tfb format.

Example:

`print_tfb_form(x+1);`**12.0.14 print\_xdvi\_form**`print_xdvi_form(S)`: It transforms  $S$  to a xdvi file and previews the file by xdvi.

Example 0:

`print_xdvi_form(newmat(2,2,[[x^2,x],[y^2-1,x/(x-1)]]));`

Example 1:

```
print_xdvi_form(print_tex_form(1/2));
```

References:

```
print_tex_form , print_dvi_form
```

### 12.0.15 print\_xv\_form

```
print_xv_form(S)
```

: It transforms  $S$  to a gif file and previews the file by xv.

```
print_xv_form(S | input=key0,format=key1)
```

: This function allows optional variables *input*, *format*

Example 0:

```
print_xv_form(newmat(2,2,[[x^2,x],[y^2-1,x/(x-1)]]));
```

Example 1:

```
print_xv_form(x+y | format="png");
```

If the optional variable `format="png"` is set, png format will be used to generate an input for xv.

References:

```
print_tex_form , print_gif_form
```

## 13 多項式(標準数学函数)

### 13.0.1 poly\_coefficient

`poly_coefficient(F, Deg, V)`

: It returns the coefficient of  $V^{\text{Deg}}$  in  $F$ .  $F$  may be rational or list or vector.

Example:

```
F=[(x+y+z)^10/z^2,(x-y+z)^10/z^3]$
poly_coefficient(F,10,x);
```

### 13.0.2 poly\_degree

`poly_degree(F)`

: It returns the degree of  $F$  with respect to the given weight vector.

`poly_degree(F | weight=key0, v=key1)`

: This function allows optional variables *weight*, *v*

Description:

The weight is given by the optional variable *weight*  $w$ . It returns  $\text{ord}_w(F)$

Example:

```
poly_degree(x^2+y^2-4 |weight=[100,1],v=[x,y]);
```

### 13.0.3 poly\_denominator

`poly_denominator(L)`

: It returns the denominator of  $L$ .  $L$  may be a list.

Example:

```
poly_denominator([1/(x^2-1),1/(x^3-1)]);
```

### 13.0.4 poly\_elimination\_ideal

`poly_elimination_ideal(I, VV)`

: It computes the intersection of the ideal  $I$  and the subring  $K[VV]$ .

`poly_elimination_ideal(I, VV |`

`grobner_basis=key0, v=key1, homo=key2, grace=key3, strategy=key4)`

: This function allows optional variables *grobner\_basis*, *v*, *homo*, *grace*, *strategy*

Description:

If *grobner\_basis* is "yes",  $I$  is assumed to be a Grobner basis. The optional variable *v* is a list of variables which defines the ring of polynomials.

Example 0:

```
poly_elimination_ideal([x^2+y^2-4,x*y-1],[x]);
```

Example 1:

```
A = poly_grobner_basis([x^2+y^2-4,x*y-1] |order=2,v=[y,x]);
```

```

        poly_elimination_ideal(A,[x]|grobner_basis="yes");
When strategy=1(default),
    nd_gr is used when trace=0(default),
    nd_gr_trace is used when trace=1.

```

References:

`gr` , `hgr` , `gr_mod` , `dp_*`

### 13.0.5 poly\_expand

`poly_expand(F)`  
: This is an alias of `poly_sort`.

References:

`poly_sort`

### 13.0.6 poly\_factor

`poly_factor(F)`  
: It factorizes the polynomial  $F$ .

Example:

```
poly_factor(x^10-y^10);
```

### 13.0.7 poly\_gcd

`poly_gcd(F,G)`  
: It computes the polynomial GCD of  $F$  and  $G$ .

Example:

```
poly_gcd(x^10-y^10,x^25-y^25);
```

### 13.0.8 poly\_gr\_w

`poly_gr_w(F,V,W)`  
: It returns the Grobner basis of  $F$  for the weight vector  $W$ . It is the second interface for `poly_grobner_basis`.

Example:

```
poly_gr_w([x^2+y^2-1,x*y-1],[x,y],[1,0]);
```

References:

`poly_in_w` , `poly_grobner_bais`

### 13.0.9 poly\_grobner\_basis

`poly_grobner_basis(I)`  
: It returns the Grobner basis of  $I$ .

`poly_grobner_basis(I | order=key0,v=key1)`  
: This function allows optional variables `order`, `v`

Description:

The optional variable  $v$  is a list of variables which defines the ring of polynomials.

Example:

```
A = poly_grobner_basis([x^2+y^2-4,x*y-1]|order=2,v=[y,x],str=1);
    A->Generators;
    A->Ring->Variables;
    A->Ring->Order;
B = poly_grobner_basis([x^2+y^2-4,x*y-1]|order=[[10,1]],v=[y,x]);
C = poly_grobner_basis([x^2+y^2-4,x*y-1]|order=[block,[0,1],[0,1]],v=[y,x]);
```

### 13.0.10 poly\_hilbert\_polynomial

`poly_hilbert_polynomial(I)`

: It returns the Hilbert polynomial of the `poly_init(I)`.

`poly_hilbert_polynomial(I | s=key0,v=key1,sm1=key2)`

: This function allows optional variables  $s$ ,  $v$ ,  $sm1$

Description:

The optional variable  $v$  is a list of variables.  $sm1=1$  forces to call `sm1`.  
 $[\text{sum}(H(k),k,0,h), H(h)]$  where  $H(h)$  is the number of degree  $h$  monomials when  $h \gg 0$ . On asir2018, it returns  $[\text{sum}(H(k),k,0,h), H(h), [H[0], H[1], \dots], F, d]$  where  $F/(1-h)^d$  is the Poincare series.

Example:

```
poly_hilbert_polynomial([x1*y1,x1*y2,x2*y1,x2*y2]|s=k,v=[x1,x2,y1,y2]);
```

### 13.0.11 poly\_ideal\_colon

`poly_ideal_colon(I,J,V)`

: It computes the colon ideal of  $I$  by  $J$   $V$  is the list of variables.

Example:

```
B=[(x+y+z)^50,(x-y+z)^50]$
V=[x,y,z]$
B=poly_ideal_colon(B,[(x+y+z)^49,(x-y+z)^49],V);
```

### 13.0.12 poly\_ideal\_intersection

`poly_ideal_intersection(I,J,V,Ord)`

: It computes the intersection of the ideal  $I$  and  $J$   $V$  is the list of variables.  
 $Ord$  is the order.

Example:

```
A=[j*h*g*f*e*d*b,j*i*g*d*c*b,j*i*h*g*d*b,j*i*h*e*b,i*e*c*b,z]$
B=[a*d-j*c,b*c,d*e-f*g*h]$
V=[a,b,c,d,e,f,g,h,i,j,z]$
poly_ideal_intersection(A,B,V,0);
```

**13.0.13 poly\_ideal\_saturation**`poly_ideal_saturation(I, J, V)`

: It computes the saturation ideal of I by J. V is the list of variables.

Example:

```

B=[(x+y+z)^50,(x-y+z)^50]$
V=[x,y,z]$
B=poly_ideal_saturation(B,[(x+y+z)^49,(x-y+z)^49],V);

```

**13.0.14 poly\_in**`poly_in(I)`: It is an alias of `poly_initial()`.`poly_in(I | order=key0, v=key1)`: This function allows optional variables *order*, *v*

Example:

```

poly_in([x^2+y^2-4,x*y-1]|order=0,v=[x,y]);

```

**13.0.15 poly\_in\_w**`poly_in_w(F, V, W)`: It returns the initial term or the initial ideal `in_w(F)` for the weight vector given by *order*. F is a single polynomial or a list of polynomials.`poly_in_w(F, V, W | gb=key0)`: This function allows optional variables *gb*

Example:

```

poly_in_w([x^2+y^2-1,x*y-x] , [x,y] , [1,0]);

```

References:

```

poly_weight_to_omatrix , ( , W , V , ) , poly_grobner_basis , poly_gr_w ,
poly_in_w_

```

**13.0.16 poly\_in\_w\_**`poly_in_w_(F)`: It returns the initial term or the initial ideal `in_w(F)` for the weight vector given by *order*. F is a single polynomial or a list of polynomials. This is a new interface of `poly_in_w` with shorter args.`poly_in_w_(F | v=key0, weight=key1, gb=key2)`: This function allows optional variables *v*, *weight*, *gb*

Example:

```

poly_in_w_([x^2+y^2-1,x*y-x] | v=[x,y],weight=[1,0]);

```

References:

```

poly_weight_to_omatrix , ( , W , V , ) , poly_grobner_basis , poly_gr_w

```

**13.0.17 poly\_initial**`poly_initial(I)`: It returns the initial ideal of  $I$  with respect to the given order.`poly_initial(I | order=key0, v=key1)`: This function allows optional variables  $order$ ,  $v$ 

Description:

The optional variable  $v$  is a list of variables. This function computes  $\text{in}_{\prec}(I)$ 

Example:

```
poly_initial([x^2+y^2-4,x*y-1] | order=0, v=[x,y]);
poly_initial([x^2+y^2-4,x*y-1] | order=0, v=[x,y], gb=1);
```

**13.0.18 poly\_initial\_coefficients**`poly_initial_coefficients(I)`: It computes the coefficients of the initial ideal of  $I$  with respect to the given order.`poly_initial_coefficients(I | order=key0, v=key1)`: This function allows optional variables  $order$ ,  $v$ 

Description:

The optional variable  $v$  is a list of variables. The order is specified by the optional variable  $order$ 

Example:

```
poly_initial_coefficients([x^2+y^2-4,x*y-1] | order=0, v=[x,y]);
```

**13.0.19 poly\_initial\_term**`poly_initial_term(F)`: It returns the initial term of a polynomial  $F$  with respect to the given weight vector.`poly_initial_term(F | weight=key0, order=key1, v=key2)`: This function allows optional variables  $weight$ ,  $order$ ,  $v$ 

Description:

The weight is given by the optional variable  $weight$   $w$ . It returns  $\text{in}_w(F)$ 

Example:

```
poly_initial_term(x^2+y^2-4 | weight=[100,1], v=[x,y]);
```

**13.0.20 poly\_lcm**`poly_lcm(L)`: It returns the LCM of  $L[0]$ ,  $L[1]$ , ...

Example:

```
poly_lcm([x^2-1, x^3-1]);
```

**13.0.21 poly\_ord\_w**`poly_ord_w(F, V, W)`

: It returns the order with respect to W of F.

Example:

`poly_ord_w(x^2+y^2-1, [x,y], [1,3]);`

References:

`poly_in_w`**13.0.22 poly\_prime\_dec**`poly_prime_dec(I, V)`

: It computes the prime ideal decomposition of the radical of I. V is a list of variables.

Example:

```

B=[x00*x11-x01*x10,x01*x12-x02*x11,x02*x13-x03*x12,x03*x14-x04*x13,
   -x11*x20+x21*x10,-x21*x12+x22*x11,-x22*x13+x23*x12,-x23*x14+x24*x13];
V=[x00,x01,x02,x03,x04,x10,x11,x12,x13,x14,x20,x21,x22,x23,x24];
poly_prime_dec(B,V | radical=1);

```

**13.0.23 poly\_r\_omatrix**`poly_r_omatrix(N)`: It gives a weight matrix, which is used to compute a Grobner basis in  $K(x)\langle dx \rangle$ ,  $|x|=|dx|=N$ .

Example:

`poly_r_omatrix(3);`

References:

`poly_weight_to_omatrix, (, W, V, ), ;`**13.0.24 poly\_solve\_linear**`poly_solve_linear(Eqs, V)`: It solves the system of linear equations *Eqs* with respect to the set of variables *V*.

Example:

`poly_solve_linear([2*x+3*y-z-2, x+y+z-1], [x,y,z]);`**13.0.25 poly\_sort**`poly_sort(F)`: It expands *F* with a given variables *v*=*V* and a given weight *w*=*W*. It returns a quote object. If *truncate* option is set, the expansion is truncated at the given degree.`poly_sort(F | v=key0,w=key1,truncate=key2)`: This function allows optional variables *v*, *w*, *truncate*

Example:

```
poly_sort((x-y-a)^3 | v=[x,y], w=[-1,-1])
returns a series expansion in terms of x and y.
```

### 13.0.26 poly\_toric\_ideal

`poly_toric_ideal(A,V)`  
: It returns generators of the affine toric ideal defined by the matrix(list)  $A$ .  $V$  is the list of variables.

Example:

```
poly_toric_ideal([[1,1,1,1],[0,1,2,3]],base_var_list(x,0,3));
```

### 13.0.27 poly\_weight\_to\_omatrix

`poly_weight_to_omatrix(W,V)`  
: It translates the weight vector  $W$  into a matrix, which is used to set the order in asir Grobner basis functions.  $V$  is the list of variables.

Example:

```
M=poly_weight_to_omatrix([2,1,0],[x,y,z]);
nd_gr([x^3+z^3-1,x*y*z-1,y^2+z^2-1,[x,y,z],0,M);
```

## 14 複体(標準数学函数)

## 15 グラフィックライブラリ(2次元)

## 16 Graphic Library (2 dimensional)

ライブラリ `glib` は, Risa/Asir のグラフィック基本関数(`draw_obj`) に対する, 昔の BASIC のような単純なインタフェースを提供する.

### 16.0.1 `glib_clear`

`glib_clear()`  
: Clear the screen.

### 16.0.2 `glib_flush`

`glib_flush()`  
: ; Flush the output. (Cfep only. It also set `initGL` to 1.).

### 16.0.3 `glib_line`

`glib_line(X0,Y0,X1,Y1)`  
: It draws the line  $[X0,Y0]$ – $[X1,Y1]$  with *color* and *shape*  
`glib_line(X0,Y0,X1,Y1 | color=key0,shape=key1)`  
: This function allows optional variables *color*, *shape*

Example:

```
glib_line(0,0,5,3/2 | color=0xff00ff);
glib_line(0,0,10,0 | shape=arrow);
```

### 16.0.4 `glib_open`

`glib_open()`  
: It starts the `ox_plot` server and opens a canvas. The canvas size is set to `Glib_canvas_x` X `Glib_canvas_y` (the default value is 400). This function is automatically called when the user calls `glib` functions.

### 16.0.5 `glib_plot`

`glib_plot(F)`  
: It plots an object  $F$  on the `glib` canvas.

Example 0:

```
glib_plot([[0,1],[0.1,0.9],[0.2,0.7],[0.3,0.5],[0.4,0.8]]);
```

Example 1:

```
glib_plot(tan(x));
```

### 16.0.6 `glib_print`

`glib_print(X,Y,Text)`  
: It put a string *Text* at  $[X,Y]$  on the `glib` canvas.

`glib_print(X,Y,Text | color=key0)`  
: This function allows optional variables *color*

Example:

```
glib_print(100,100,"Hello Worlds" | color=0xff0000);
```

### 16.0.7 glib\_ps\_form

`glib_ps_form(S)`

: It returns the PS code generated by executing *S* (experimental).

Example 0:

```
glib_ps_form(quote( glib_line(0,0,100,100) ));
```

Example 1:

```
glib_ps_form(quote([glib_line(0,0,100,100),glib_line(100,0,0,100)]));
```

References:

`glib_tops`

### 16.0.8 glib\_putpixel

`glib_putpixel(X,Y)`

: It puts a pixel at [*X*,*Y*] with *color*

`glib_putpixel(X,Y | color=key0)`

: This function allows optional variables *color*

Example:

```
glib_putpixel(1,2 | color=0xffff00);
```

### 16.0.9 glib\_remove\_last

`glib_remove_last()`

: Remove the last object. `glib_flush()` should also be called to remove the last object. (cfep only).

### 16.0.10 glib\_set\_pixel\_size

`glib_set_pixel_size(P)`

: Set the size of putpixel to *P*. 1.0 is the default. (cfep only).

### 16.0.11 glib\_tops

`glib_tops()`

: If `Glib_ps` is set to 1, it returns a postscript program to draw the picture on the canvas.

References:

`print_output`

### 16.0.12 glib\_window

`glib_window(Xmin,Ymin,Xmax,Ymax)`

: It generates a window with the left top corner [*Xmin*,*Ymin*] and the right bottom corner [*Xmax*,*Ymax*]. If the global variable *Glib\_math\_coordinate* is set to 1, mathematical coordinate system will be employed, i.e., the left top corner will have the coordinate [*Xmin*,*Ymax*].

Example:

```
glib_window(-1,-1,10,10);
```

## 17 OpenXM-Contrib 一般函数

### 17.1 函数一覧

#### 17.1.1 ox\_check\_errors2

`ox_check_errors2(p)`

:: 識別番号 $p$  のサーバのスタック上にあるエラーオブジェクトをリストで戻す.

*return*      リスト

$p$             数

- 識別番号 $p$  のサーバのスタック上にあるエラーオブジェクトをリストで戻す.
- エラーオブジェクトのポップはしない.

```
[219] P=sm1.start();
```

```
0
```

```
[220] sm1.sm1(P," 0 get ");
```

```
0
```

```
[221] ox_check_errors2(P);
```

```
[error([7,4294967295,executeString: Usage:get])]
```

```
Error on the server of the process number = 1
```

```
To clean the stack of the ox server,
```

```
type in ox_pops(P,N) (P: process number, N: the number of data you need to pop)
out of the debug mode.
```

```
If you like to automatically clean data on the server stack,
```

```
set XM_debug=0;
```

## 18 OXshell の関数

OXshell はシステムのコマンドを ox server より実行する仕組みである. 詳しくは OpenXM/src/kan96xx/Doc/oxshell.oxw および OpenXM/doc/Papers/rims-2003-12-16-ja.tex を見よ.

### 18.0.1 oxshell.get\_value

`oxshell.get_value(NAME, V)`

: It get the value of the variable *NAME* on the server *ox\_shell*.

Example:

```
oxshell.set_value("abc", "Hello world!");
oxshell.oxshell(["cp", "stringIn://abc", "stringOut://result"]);
oxshell.get_value("result");
```

What we do is a file \$TMP/abc\* is generated with the contents Hello world! and copied to the variable result on ox\_sm1.  
The contents of the file is stored in the variable result on ox\_sm1.

References:

`oxshell.oxshell` , `oxshell.set_value`

### 18.0.2 oxshell.oxshell

`oxshell.oxshell(L)`

: It executes command *L* on a *ox\_shell* server. *L* must be an array. The result is the outputs to stdout and stderr. A temporary file will be generated under \$TMP. cf. `oxshell.keep_tmp()`

Example:

```
oxshell.oxshell(["ls"]);
```

References:

`ox_shell` , `oxshell.set_value` , `oxshell.get_value` , `oxshell` , `of` , `sm1`.

### 18.0.3 oxshell.set\_value

`oxshell.set_value(NAME, V)`

: It set the value *V* to the variable *Name* on the server *ox\_shell*.

Example:

```
oxshell.set_value("abc", "Hello world!");
oxshell.oxshell(["cat", "stringIn://abc"]);
```

References:

`oxshell.oxshell` , `oxshell.get_value`

## 19 Asir システム管理関数

### 19.0.1 asir\_contrib\_update

`asir_contrib_update()`

: It updates the asir-contrib library and/or some other files to the HEAD branch. The usage will be shown by `asir_contrib_update()` without the option `update`. Options are `update`, `clean`, `url`, `install_dir`, `zip_files`, `tmp`. Default values `update=0`, `clean=0`, `url="http://www.math.kobe-u.ac.jp/OpenXM/Current"`, `install_dir=%APPDATA%/OpenXM (win) or install_dir=$OpenXM_tmp/OpenXM (others)` `zip_files=["lib-asir-contrib.zip"]`

Example:

```
asir_contrib_update();
asir_contrib_update(|update=1);    update the library
asir_contrib_update(|update=3);    update the library and the documents
asir_contrib_update(|clean=1);
asir_contrib_update(|zip_files=["lib-asir-contrib.zip","doc-asir2000.zip","doc-asir
```

## 20 便利な関数

システムの資源にアクセスするためおよび文字列処理の便利な関数を集めてある.

### 20.0.1 util\_damepathq

`util_damepathq(S)`

: When *S* is a string by the ShiftJIS code and *S* contains dame-moji with respect to \, it returns [a non-zero number, the string].

Example:

```
T = [0x5c,0xe4,0x5c,0x41,0x42]$
T2=asciitostr(T)$
util_damepathq(T2);
```

### 20.0.2 util\_file\_exists

`util_file_exists(Fname)`

: It returns 1 when *Fname* exists. It returns 0 when *Fname* does not exist.

### 20.0.3 util\_filter

`util_filter(Command,Input)`

: It executes the filter program *Command* with the *Input* and returns the output of the filter as a string.

`util_filter(Command,Input | env=key0)`

: This function allows optional variables *env*

Example:

```
util_filter("sort","cat\ndog\ncentipede\n");
```

### 20.0.4 util\_find\_and\_replace

`util_find_and_replace(W,S,Wnew)`

: It replaces *W* in *S* by *Wnew*. Arguments must be lists of ascii codes or strings.

### 20.0.5 util\_find\_start

`util_find_start()`

: It tries to find the gnome-open command or an installed browser in unix systems. It returns "open" on MacOS X and returns "start" on Windows.

`util_find_start( | browser=key0)`

: This function allows optional variables *browser*

### 20.0.6 util\_find\_substr

`util_find_substr(W,S)`

: It returns the position of *W* in *S*. If *W* cannot be found, it returns -1. Arguments must be lists of ascii codes or strings.

### 20.0.7 util\_index

`util_index(V)`

: It returns the name part and the index part of  $V$ .

Example:

```
util_index(x_2_3)
```

References:

`util_v`

### 20.0.8 util\_load\_file\_as\_a\_string

`util_load_file_as_a_string(F)`

: It reads a file  $F$  as a string.

### 20.0.9 util\_part

`util_part(S,P,Q)`

: It returns from  $P$ th element to  $Q$ th element of  $S$ .

### 20.0.10 util\_read\_file\_as\_a\_string

`util_read_file_as_a_string(F)`

: It reads a file  $F$  as a string.

### 20.0.11 util\_remove\_cr

`util_remove_cr(S)`

: It removes `cr/lf/tabs` from  $S$ . Arguments must be a list of ascii codes.

### 20.0.12 util\_timing

`util_timing(Q)`

: Show the timing data to execute  $Q$ .

Example:

```
util_timing( quote( fctr(x^50-y^50) ));
```

### 20.0.13 util\_v

`util_v(V,L)`

: It returns a variable indexed by  $L$ .

Example:

```
util_v("x",[1,3]);
```

References:

`util_index`

### 20.0.14 util\_write\_string\_to\_a\_file

`util_write_string_to_a_file(Fname,S)`

: It writes a string  $S$  to a file  $Fname$ .

## 21 その他のマニュアル

この節では asir-contrib のその他のマニュアルを紹介する.

それからまだ分類がおわっていない関数を解説する. これらの関数は将来は別の独立した節へ移す予定である.

### 21.0.1 dsolv (Solving the initial ideal for holonomic systems)

`../dsolv-html/dsolv-ja.html`

### 21.0.2 gtt\_ekn (Two way contingency tables by HGM)

`../gtt_ekn-html/gtt_ekn-ja.html`

### 21.0.3 f\_res (Comuting resultant)

`../f_res-html/f_res-ja.html`

### 21.0.4 (gnuplot ox server for graphics)

`../gnuplot-html/gnuplot-ja.html`

### 21.0.5 mathematica (Mathematica (TM) ox server)

`../mathematica-html/mathematica-ja.html`

### 21.0.6 mt\_graph (3D grapher)

`../mk_graph-html/mk_graph-ja.html`

### 21.0.7 mt\_gkz (Intersection matrix of GKZ systems, English)

`../mt_gkz-html/mt_gkz-ja.html`

### 21.0.8 n\_wishartd (restriction of matrix 1F1)

`../n_wishartd-html/n_wishartd-ja.html`

### 21.0.9 nn\_ndbf (local b-function)

`../nn_ndbf-html/nn_ndbf-ja.html`

### 21.0.10 noro\_mwl (Mordel Weil Lattice)

`../noro_mwl-html/noro_mwl-ja.html`

### 21.0.11 noro\_pd (New Primary Ideal Decomposition)

`../noro_pd-html/noro_pd-ja.html`

### 21.0.12 noro\_module\_syz (syzygies for modules)

`../noro_module_syz-html/noro_module_syz-ja.html`

### 21.0.13 ns\_twistedlog (twisted logarithmic cohomology group)

`../ns_twistedlog-html/ns_twistedlog-ja.html`

**21.0.14 nk\_fb\_gen\_c (Fisher Bingham MLE)**

../nk\_fb\_gen\_c-html/nk\_fb\_gen\_c-ja.html

**21.0.15 ok\_diff (Okutani's library for differential operators)**

../ok\_diff-html/ok\_diff-ja.html

**21.0.16 ok\_dmodule (Okutani's library for D-modules)**

../ok\_dmodule-html/ok\_dmodule-ja.html

**21.0.17 om (om (java) ox server for translating CMO and OpenMath)**

../om-html/om-ja.html

**21.0.18 ox\_pari (OpenXM pari server)**

../ox\_pari-html/ox\_pari-ja.html

**21.0.19 (Plucker relations)**

../plucker-html/plucker-ja.html

**21.0.20 pfpcoh (Ohara's library for homology/cohomology groups for  $p \neq q$ )**

../pfpcoh-html/pfpcoh-ja.html

**21.0.21 phc (PHC ox server for solving systems of algebraic equations by the homotopy method)**

../phc-html/phc-ja.html

**21.0.22 sm1 (Kan/sm1 ox server for the ring of differential operators)**

../sm1-html/sm1-ja.html

**21.0.23 tigers (tigers ox server for toric universal Grobner bases)**

../tigers-html/tigers-ja.html

**21.0.24 todo\_parametrize**

../todo\_parametrize-html/todo\_parametrize-ja.html

パッケージ `todo_parametrize/todo_parametrize.rr` をロードすることにより, 有理曲線のパラメータ表示を見付ける関数である, `parameterize` が利用できるようになる. 詳しくは See Section “概要” in *Risa/Asir 代数曲線論用パッケージ説明書* を見よ (Web 版 *Risa/Asir 代数曲線論用パッケージ説明書* ([http://www.math.kobe-u.ac.jp/OpenXM/Current/doc/asir-contrib/html-ja/todo\\_parametrize/todo\\_parametrize\\_ja\\_toc.html](http://www.math.kobe-u.ac.jp/OpenXM/Current/doc/asir-contrib/html-ja/todo_parametrize/todo_parametrize_ja_toc.html))). このパッケージのマニュアルへの統合はまだできていない. このパッケージはまだ module 構造を利用していないので, 既存のライブラリと名前の衝突の可能性がある.

```
[1205] load("todo_parametrize/todo_parametrize.rr");
```

```

1
[1425] parametrize(y^2-x^3);
[155*t^2+20*t+1,720*t^4+1044*t^3+580*t^2,155*t^4+20*t^3+t^2,(-x)/(y)]
[1426] parametrize(y^2+x^3);
[-t,1,t^3,(-x)/(y)]

```

### 21.0.25 taji\_alc

../taji\_alc-html/taji\_alc-ja.html

パッケージ `taji_alc.rr` をロードすることにより, 一変数代数的コホモロジ群に関連する関数をロードできる. (Web 版 Risa/Asir 一変数代数的局所コホモロジー類に関する Risa/Aisir パッケージ説明書 ([http://www.math.kobe-u.ac.jp/OpenXM/Current/doc/asir-contrib/ja/taji\\_alc-html/taji\\_alc-ja\\_toc.html](http://www.math.kobe-u.ac.jp/OpenXM/Current/doc/asir-contrib/ja/taji_alc-html/taji_alc-ja_toc.html))).

```

import("taji_alc.rr");
taji_alc.laurent_expansion(x,(x-1)^3);

```

### 21.0.26 Texinfo でないマニュアル, 論文等.

OpenXM documents (<http://www.math.kobe-u.ac.jp/OpenXM/Current/doc/index-doc-ja.html>). には texinfo で書かれていない asir-contrib のファイルや関数のマニュアル, および関連論文へのリンクがある.

(yang, fj-curve, nk\_mora 等)

## 索引

(インデックスがありません)

(インデックスがありません)

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