

OpenXM/Risa/Asir-Contrib

OpenXM/Risa/Asir-Contrib User's Manual (English Edition)
Edition 1.3.2-3 for OpenXM/Asir2000
March 2017 (minor update on 28 March 2025)

by OpenXM Developing Team

1 Introduction

The computer algebra system `asir` can use servers, which support the `OpenXM` protocols (Open message eXchange for Mathematics, <http://www.openxm.org>), as components. The interface functions to call these servers are loaded by loading the file `OpenXM/rc/asirrc`. This file is automatically loaded in "Risa/Asir(OpenXM distribution)", which we call `OpenXM/Risa/Asir` in this document. This document explains these interface functions for `asir` and several mathematical and utility functions written in the user languages of Risa/Asir. These mathematical and utility functions are outcome of the Asir-contrib project.

The latest asir-contrib manual of the HEAD branch is at <http://www.math.kobe-u.ac.jp/OpenXM/Current/doc/index-doc.html>

As to technical details on the `OpenXM` protocols, see `openxm-en.tex` at `$(OpenXM_HOME)/doc/OpenXM-specs`.

Enjoy mathematics on your computer.

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)

See `OpenXM/Copyright` for the copyright notice.

2 How to load Asir/Contrib

With loading `OpenXM/rc/asirrc`, we can use most functions in Asir/Contrib. The `OpenXM/Risa/Asir` reads this file, which is specified by the `ASIR_CONFIG` environmental variable, when it starts. The file `names.rr` is the top level file of the Asir/Contrib. Most other files are loaded from `names.rr`. Some packages are not loaded from `names.rr` and they must be loaded individually.

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 Function Names in Asir Contrib

Not yet written.

Not yet written.

4 Asir-contrib for Windows

A part of Asir-contrib works on Windows. The following functions and components work on windows; the outer component sm1 and functions in asir-contrib which do not call outer components. In the cygwin environment, the outer components sm1, phc work. The other outer components do not work.

The following functions do not work on Windows. Some of them work in the cygwin environment of Windows.

- 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 Basic (Standard Functions)

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_ith

`base_ith(A, I)`
: It returns $A[I]$.

Example:

```
R=[[x,10],[y,20]]; map(base_ith,R,0);
```

5.0.9 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);
```

5.0.10 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]);
```

5.0.11 base_permutation

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

Example:

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

5.0.12 base_position

`base_position(A, S)`
: It returns the position of A in S .

Example:

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


5.0.13 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`.

5.0.14 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);
```

5.0.15 base_prune

`base_prune(A, S)`

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

Example:

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

5.0.16 base_range

`base_range(Start, End)`

: It returns a list numbers [*Start*, *Start*+*Step*, *Start*+2**Step*, ..., *Start*+*n***Step*] where *Start*+*n***Step* < *End* <= *Start*+(*n*+1)**Step* Default value of *step* is 1.

`base_range(Start, End | step=Step=key0)`

: This function allows optional variables *step=Step*

Example:

```
base_range(0,10);
```

5.0.17 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]]`

5.0.18 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 .**5.0.19 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 .**5.0.20 base_rest**`base_rest(L)`: It returns `cdr(L)`.

Example:

`R=[[x,10,30],[y,20,40]]; map(base_rest,R);`**5.0.21 base_set_intersection**`base_set_intersection(A,B)`: $A \cap B$

Example:

`base_set_intersection([1,2,3],[3,4,5]);`**5.0.22 base_set_minus**`base_set_minus(A,B)`: $A \setminus B$

Example:

`base_set_minus([1,2,3],[3,4,5]);`**5.0.23 base_set_union**`base_set_union(A,B)`: $A \cup B$

Example:

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

5.0.24 base_subsequenceq**base_subsequenceq**(*A*,*B*): if *A* is a subsequence *B*, then it returns 1 else 0.

Example:

`base_subsequence([3,2,5],[1,2,3,4,5]);`**5.0.25 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]);`**5.0.26 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]);`**5.0.27 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);`**5.0.28 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 Numbers (Standard Mathematical Functions)

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_setprec(30); //About 30 digits after the decimal point. It also s
```

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);`**6.0.10 number_setprec**`number_setprec(X)`

: When X is 0, it returns the current value of precision.

Example:

`number_setprec(30);``number_float_to_rational(F)` returns

an approximation of F by a rational number with the accuracy about 30 digits after the decimal point.

It also calls `setprec(30);`

7 Calculus (Standard Mathematical Functions)

8 Series (Standard Mathematical Functions)

9 Special Functions (Standard Mathematical Functions)

Not yet written

10 Matrix (Standard Mathematical Functions)

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_is_zero**matrix_is_zero(*A*)**

: If it is 0 matrix or 0 vector or list consisting of 0, then it returns 1 else it returns 0.

Example:

`matrix_is_zero(newmat(2,3));`**10.0.14 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]]);`**10.0.15 matrix_kronecker_product****matrix_kronecker_product(*A*,*B*)**: Kronecker product of the matrices *A* and *B*.

Example:

`matrix_kronecker_product([[a11,a12],[a21,a22]],[[b11,b12],[b21,b22]]);`**10.0.16 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`**10.0.17 matrix_matrix_to_list****matrix_matrix_to_list(*M*)**: It translates the matrix *M* to a list.

References:

`matrix_list_to_matrix`**10.0.18 matrix_ones****matrix_ones(*N*)**: It returns the vector [1 1 ... 1] of length *N*. When *one*=*m*, it returns [m m ... m]. When *size*=[*p*,*q*] is given, *N* is ignored and returns *p* by *q* matrix with entries 1.**matrix_ones(*N* | *one*=*m*=key0,*size*=[*p*=key1,*q*]=key2)**: This function allows optional variables *one*=*m*, *size*=[*p*, *q*]

Example:

`vtol(matrix_ones(3));` returns the list [1,1,1]

10.0.19 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]])]]);
```

10.0.20 matrix_rank**matrix_rank**(*M*): It returns the rank of the matrix *M*.

Example:

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

10.0.21 matrix_rank_ff**matrix_rank_ff**(*Mat*, *P*): It evaluates the rank of the matrix *Mat* by mod *P*. Entries may be rational numbers, and the inverse of the denominator *D* in *F_P* is properly computed when *P* does not divide *D*, but the case *P* divides *D* does not raise an error.**10.0.22 matrix_row_matrix****matrix_row_matrix**(*L*): It returns $1 \times n$ matrix $[[L, L, \dots, L]]$ when *L* is a scalar. It returns $1 \times \text{length}(L)$ matrix *L*.**matrix_row_matrix**(*L* | *size=n=key0*): This function allows optional variables *size=n*

Example:

```
matrix_row_matrix(1 | size=5);
```

10.0.23 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]);
```

10.0.24 matrix_stack**matrix_stack**(*A*, *B*): Stack the matrices *A* and *B*.

Example:

```
matrix_stack([[a11,a12], [a21,a22]], [[b11,b12], [b21,b22]]);
```

10.0.25 `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]);`**10.0.26** `matrix_transpose``matrix_transpose(M)`: It returns the transpose of the matrix M .

References:

`matrix_list_to_matrix`

11 Graphic (Standard Mathematical Functions)

Not yet written.

12 Print (Standard Mathematical Functions)

12.0.1 print_c_form

`print_c_form(S)`

: It transforms S to the C format or python format string.

Example 0:

```
print_c_form(x^2+1);
```

Example 1:

```
print_c_form(x^2+1 | mode=python);
```

Example 2:

```
print_c_form(sin(x^2+1)/5 | mode=c);
```

12.0.2 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
```

12.0.3 print_em

`print_em(S)`

: It outputs S by a font to emphasize it.

Example:

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

12.0.4 print_format

`print_format(S)`

: It changes the list format of S . Options are list, sep. Defaults are list=["", ""], sep=",".

Example 0:

```
print_format([1,[x,y^2]]);
```

Example 1:

```
print_format([1,[x,y^2]] | list=["(",")"], sep=" ");
```

Example 2:

```
print_format(print_c_form([1,[x,y^2]]) );
```

12.0.5 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`

12.0.6 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));
```

12.0.7 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));
```

12.0.8 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

12.0.9 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 , ( , )
```

12.0.10 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
```

12.0.11 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));
```

Optimal variabes: nopreview=1 does not preview the PDF file.

References:

```
print_tex_form , print_xdvi_form
```

12.0.12 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
```

12.0.13 print_terminal_form

```
print_terminal_form(S)
```

: It transforms S to the terminal form???

12.0.14 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`

12.0.15 print_tfb_form

`print_tfb_form(S)`

: It transforms S to the tfb format.

Example:

```
print_tfb_form(x+1);
```

12.0.16 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) | texstr=1);
```

References:

`print_tex_form`, `print_dvi_form`

12.0.17 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 Polynomials (Standard Mathematical Functions)

13.0.1 poly_coefficient

`poly_coefficient(F, Deg, V)`

: It returns the coefficient of V^{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_coefficients_list

`poly_coefficients_list(F, V)`

: It returns the list of coefficients of F with respect to the variable list V . F may be rational or list or vector.

Example:

```
F=[(x+y+c*z)^2/c^2, (x-y+c*z)^2/c^3]$
poly_coefficients_list(F, [x,y,z]);
```

13.0.3 poly_coefficients_of_monomial_list

`poly_coefficients_of_monomial_list(F, VV)`

: It returns the list of coefficients of F with respect to a list of monomials VV .

Example:

```
poly_coefficients_of_monomial_list(2+3*x+4*z, [1,x,y,z]);
poly_coefficients_of_monomial_list((x+z)^3+5*y, [1,x,y,z,x^2*z]);
poly_coefficients_of_monomial_list([(x+y)^3,x+y], [x,x^2,x^3,x^2*y,x*y^2,y^3]);
```

References:

`poly_construct_from_coefficients_of_monomial_list`

13.0.4 poly_construct_from_coefficients_of_monomial_list

`poly_construct_from_coefficients_of_monomial_list(L, VV)`

: It returns the inner product of L and VV .

Example:

```
L=tk_poly_coefficients_of_monomial_list((x+y)^3, VV=[x,x^2,x^3,x^2*y,x*y^2,y^3]);
poly_construct_from_coefficients_of_monomial_list(L, VV);
```

References:

`poly_coefficients_of_monomial_list`

13.0.5 poly_dact**poly_dact**(Op,F,XL)

: Act the differential operator Op to F. XL is a list of x variables.

Example:

```
poly_dact( x*dx+y*dy+a, x^(-3)*y^(-2), [x,y]);
```

13.0.6 poly_decompose_by_weight**poly_decompose_by_weight**(F,V,W)

: decompose F into homogeneous components with respect to the variable V with the weight W. The return value is [[Max_ord,Min_ord],[component of Max_ord, ..., component of Min_ord]];

Example:

```
poly_decompose_by_weight(x^2*dx^2-x*(x*dx+y*dy+a), [x,y,dx,dy], [-1,-1,1,1]);
```

13.0.7 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]);
```

13.0.8 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)]);
```

13.0.9 poly_diff2euler**poly_diff2euler**(Op,XL): Express the differential operator Op by the euler operators. XL is a list of x variables. When XL=[x,y], dx,dy are differential operators and tx,ty are Euler operators (tx=x*dx, ty=y*dy). t stands for theta. When the return value is R, $R[0]*R[1]=Op$.

Example:

```
poly_diff2euler(dx^2-a*x,[x]);
```

13.0.10 poly_dmul

`poly_dmul(Op1,Op2,XL)`
 : Multiply Op1 and Op2 in the Weyl algebra (the ring of differential operators).
 XL is a list of x variables.

Example:

```
poly_dmul( x*dx+y*dy+a*x, x*y*dx*dy, [x,y]);
```

13.0.11 poly_dvar

`poly_dvar(V)`
 : Add d to the variable name V.

Example:

```
poly_dvar([x1,x2,x3]);
poly_dvar([x1,x2,x3] | d=t);
```

13.0.12 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,gb=key1,v=key2,homo=key3,grace=key4,strategy=key5)`
 : This function allows optional variables *grobner_basis*, *gb*, *v*, *homo*, *grace*, *strategy*

Description:

If *grobner_basis* is "yes" or *gb*=1, *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_**

13.0.13 poly_euler2diff

`poly_euler2diff(Op,XL)`
 : Translate the differential operator Op expressed in terms of euler operators into the operators in terms of d. XL is a list of x variables. When XL=[x,y], dx,dy are differential operators and tx,ty are Euler operators (tx=x*dx, ty=y*dy). t stands for theta.

Example:

```
poly_euler2diff(tx^2-x*(tx+1/2)^2,[x]);
```

13.0.14 poly_expand

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

References:

`poly_sort`

13.0.15 poly_factor

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

Example:

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

13.0.16 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);
```

13.0.17 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_basis`

13.0.18 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. Other Options; *p* (characteristic), *homo*, *method* (`nd_gr_trace`(default), `nd_gr`, `nd_weyl_gr`, `nd_weyl_gr_trace`, `nd_f4`, `nd_f4_trace`), *order_matrix*, *order*. See also *asir manual*. alias; `poly_groebner_basis`

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]);

```

13.0.19 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]);
```

13.0.20 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);

```

13.0.21 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);

```

13.0.22 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);
```

13.0.23 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]);
poly_in([x^2+y^2-4,x*y-1]|order=[1,0],v=[x,y]);
```

13.0.24 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` , `poly_grobner_basis` , `poly_gr_w` , `poly_in_w_`

13.0.25 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` , `poly_grobner_basis` , `poly_gr_w`

13.0.26 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 $\text{in}_<(I)$

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

13.0.27 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]);
```

13.0.28 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]);
```

13.0.29 poly_lcm`poly_lcm(L)`: It returns the LCM of $L[0]$, $L[1]$, ...

Example:

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

13.0.30 poly_numerator`poly_numerator(L)`

: It returns the numerator of L. L may be a list.

Example:

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

13.0.31 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`**13.0.32 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);
```

13.0.33 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);
When the option lex is given, the last lex variables are
compared firstly by the lexicographic order, e.g.,
poly_r_omatrix(4 | lex=2) is compared by the matrix
0 0 0 0   0 0 0 1
0 0 0 0   0 0 1 0
0 0 0 0   1 1 0 0
....
```

References:

`poly_weight_to_omatrix`

13.0.34 poly_replace_factor

`poly_replace_factor(F, Rule)`
 : It factorizes F and replaces factors by the Rule.

Example:

```
poly_replace_factor(2*x/((x-y)^3*y), [[x-y,s]]);
It returns 2*x/(s^3*y).
```

13.0.35 poly_solve_linear

`poly_solve_linear(Eqs, V)`
 : It solves the system of linear equations Eqs with respect to the set of variables V . When the option `p=P` is given, it solves the system by mod P . When the option `reverse=1` is given, the lex order of `reverse(V)` is used.

Example:

```
poly_solve_linear([2*x+3*y-z-2, x+y+z-1], [x,y,z]);
poly_solve_linear([2*x+3*y-z-2, x+y+z-1], [x,y,z] | p=13);
```

13.0.36 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.
```

13.0.37 poly_subsetq

`poly_subsetq(II, JJ, V)`
 : If the ideal II is contained in the ideal JJ , it returns 1, else 0.

Example:

```
poly_subsetq([x^2-1, (x-1)*(y-2)], [x-1, y-2], [x,y]);
```

Optimal variables: `gb=1` (if JJ is already a GB). `verbose=1` Note that when `gb=1`, the order must not be changed since the GB of JJ was computed. Otherwise, this function does not give correct answer or stucks. If `gb=1` is not given, `dp_ord(0)` is executed in this function.

13.0.38 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));
```

Optimal variables: nk_toric=1 (disable 4ti2)

13.0.39 poly_w_marking

`poly_w_marking(Id,V,W)`

: The monomials x^a in Id is rewritten to $x^a t_w^{<a,w>+b}$. $<a,w>$ is the inner product and b is an integer to avoid negative powers of t_w . Return value is $[w\text{-marked polynomial}, b]$

Example:

```
poly_w_marking(x*dx^2+y*dy+a,[x,y,dx,dy],[-1,-1,1,1]);
[t_w*x*dx^2+y*dy+a,0]
```

Optimal variables: specify a name of homogenization variable by the option `hvar`. The default is t_w .

13.0.40 poly_weight_to_omatrix

`poly_weight_to_omatrix(W,V)`

: [obsoleted] 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]);
```

13.0.41 poly_weight_to_ord_matrix

`poly_weight_to_ord_matrix(W)`

: Weight vector W is transformed to a matrix defined order for `dp_ord`, `nd_gr`, ... It is a new version of `poly_weight_to_omatrix(W,V)` [obsoleted]

Example:

```
Mat=poly_weight_to_ord_matrix([1,1,1,1,0,1,1,1,1,0]);
Mat=poly_weight_to_ord_matrix([],tie_breaker=[lex,0,1,2,3,5,6,7,8,4,9]);
```

Optimal variables: `tie_breaker=[lex,n1,n2,n3,...]` defines the lexicographic order $x_{n1}, x_{n2}, x_{n3}, \dots$ when variables are x_*

13.0.42 poly_weyl_subsetq

`poly_weyl_subsetq(II,JJ,V)`

: If the ideal II in the Weyl algebra is contained in the ideal JJ , it returns 1, else 0.

Example:

```
poly_weyl_subsetq([x*dx^2],[x*dx-1],[x,dx]);
```

Optimal variabes: gb=1 (if JJ is already a GB). verbose=1. Note that when gb=1, the order must not be changed since the GB of JJ was computed. Otherwise, this function does not give correct answer or stuck. If gb=1 is not given, dp_ord(0) is executed in this function.

14 Complex (Standard Mathematical Functions)

15 Graphic Library (2 dimensional)

The library `glib` provides a simple interface like old BASIC to the graphic primitive (`draw_obj`) of Risa/Asir.

15.0.1 `glib_clear`

`glib_clear()`
: Clear the screen.

15.0.2 `glib_flush`

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

15.0.3 `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);
```

15.0.4 `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.

15.0.5 `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));
```

15.0.6 `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);
```


15.0.7 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`

15.0.8 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);
```

15.0.9 glib_remove_last

`glib_remove_last()`

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

15.0.10 glib_set_pixel_size

`glib_set_pixel_size(P)`

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

15.0.11 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`

15.0.12 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);
```

16 OpenXM-Contrib General Functions

16.1 Functions

16.1.1 ox_check_errors2

`ox_check_errors2(p)`

:: get a list of error objects on the stack of the server *p*.

return List

p Number

- It gets a list of error objects on the server stack.
- It does not pop the error objects.

```
[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;
```

17 OXshell Functions

OXshell is a system to execute system commands from ox servers. As to details, see the files OpenXM/src/kan96xx/Doc/oxshell.oxw and OpenXM/doc/Papers/rims-2003-12-16-ja.tex.

17.0.1 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 copi

The contents of the file is stored in the variable result on *ox_sm1*.

References:

oxshell.oxshell , *oxshell.set_value*

17.0.2 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*.

17.0.3 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*

18 Asir System Utility Functions

18.0.1 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
```

19 Utility Functions

Utility functions provide some useful functions to access to the system and to process strings.

19.0.1 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);
```

19.0.2 util_file_exists

`util_file_exists(Fname)`

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

19.0.3 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");
```

19.0.4 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.

19.0.5 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*

19.0.6 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.

19.0.7 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`

19.0.8 util_load_file_as_a_string

`util_load_file_as_a_string(F)`

: It reads a file F as a string.

19.0.9 util_part

`util_part(S,P,Q)`

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

19.0.10 util_read_file_as_a_string

`util_read_file_as_a_string(F)`

: It reads a file F as a string.

19.0.11 util_remove_cr

`util_remove_cr(S)`

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

19.0.12 util_timing

`util_timing(Q)`

: Show the timing data to execute Q .

Example:

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

19.0.13 util_v

`util_v(V,L)`

: It returns a variable indexed by L .

Example:

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

References:

`util_index`

19.0.14 util_write_string_to_a_file

`util_write_string_to_a_file(Fname,S)`

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

20 Other Manuals

This section introduces other manuals in the asir-contrib project.

This section also describes functions that have not yet been classified. These will be moved to independent sections in a future.

20.0.1 dsolv (Solving the initial ideal for holonomic systems)

`../dsolv-html/dsolv-en.html`

20.0.2 gtt_ekn (Two way contingency tables by HGM)

`../gtt_ekn-html/gtt_ekn-en.html`

20.0.3 f_res (Comuting resultant)

`../f_res-html/f_res-en.html`

20.0.4 (gnuplot ox server for graphics)

`../gnuplot-html/gnuplot-en.html`

20.0.5 mathematica (Mathematica (TM) ox server)

`../mathematica-html/mathematica-en.html`

20.0.6 mt_graph (3D grapher)

`../mk_graph-html/mk_graph-en.html`

20.0.7 mt_gkz (Intersection matrix of GKZ systems)

`../mt_gkz-html/mt_gkz-en.html`

20.0.8 mt_mm (Macaulay matrix method)

`../mt_mm-html/mt_mm-en.html`

20.0.9 n_wishartd (restriction of matrix 1F1)

`../n_wishartd-html/n_wishartd-en.html`

20.0.10 nn_ndbf (local b-function)

`../nn_ndbf-html/nn_ndbf-en.html`

20.0.11 noro_mwl (Mordel Weil Lattice)

`../noro_mwl-html/noro_mwl-en.html`

20.0.12 noro_module_syz (syzygies for modules)

`../noro_module_syz-html/noro_module_syz-en.html`

20.0.13 ns_twistedlog (twisted logarithmic cohomology group)

`../ns_twistedlog-html/ns_twistedlog-en.html`

20.0.14 nk_fb_gen_c (Fisher Bingham MLE)

`../nk_fb_gen_c-html/nk_fb_gen_c-en.html`

20.0.15 ok_diff (Okutani's library for differential operators)

`../ok_diff-html/ok_diff-en.html`

20.0.16 ok_dmodule (Okutani's library for D-modules)

`../ok_dmodule-html/ok_dmodule-en.html`

20.0.17 om (om (java) ox server for translating CMO and OpenMath)

`../om-html/om-en.html`

20.0.18 ox_pari (OpenXM pari server)

`../ox_pari-html/ox_pari-en.html`

20.0.19 (Plucker relations)

`../plucker-html/plucker-en.html`

20.0.20 pfpcoh (Ohara's library for homology/cohomology groups for $p \nmid q$)

`../pfpcoh-html/pfpcoh-en.html`

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

`../phc-html/phc-en.html`

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

`../sm1-html/sm1-en.html`

20.0.23 tigers (tigers ox server for toric universal Grobner bases)

`../tigers-html/tigers-en.html`

20.0.24 tk_ode_by_mpfr (Generating C codes for numerical analysis of ODE by MPFR, document in Japanese)

`../tk_ode_by_mpfr-html/tk_ode_by_mpfr-ja.html`

20.0.25 `[[todo_parametrize]]`

`todo_parametrize/todo_parametrize-toc`

With loading the file `todo_parametrize/todo_parametrize.rr` the function `parametrize` is installed. The function finds a parametric expression of a given rational curve. As to details, see *See A package for algebraic curves* (in Japanese).

```
[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)]

```

20.0.26 taji_alc

With loading the file `taji_alc.rr` functions for algebraic local cohomology groups in one variable are imported.

```

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

```

20.0.27 Manual and papers which are not written in texinfo.

Links to manuals and papers related to files and commands in `asir-contrib` are at OpenXM documents (<http://www.math.kobe-u.ac.jp/OpenXM/Current/doc/index-doc-en.html>).

Index

(Index is nonexistent)

(Index is nonexistent)

Short Contents

1	Introduction.....	1
2	How to load Asir/Contrib.....	3
3	Function Names in Asir Contrib.....	4
4	Asir-contrib for Windows	5
5	Basic (Standard Functions)	6
6	Numbers (Standard Mathematical Functions).....	11
7	Calculus (Standard Mathematical Functions)	13
8	Series (Standard Mathematical Functions)	14
9	Special Functions (Standard Mathematical Functions).....	15
10	Matrix (Standard Mathematical Functions)	16
11	Graphic (Standard Mathematical Functions)	21
12	Print (Standard Mathematical Functions).....	22
13	Polynomials (Standard Mathematical Functions)	27
14	Complex (Standard Mathematical Functions).....	38
15	Graphic Library (2 dimensional)	39
16	OpenXM-Contrib General Functions	41
17	OXshell Functions	42
18	Asir System Utility Functions.....	43
19	Utility Functions	44
20	Other Manuals.....	46
	Index	49

Table of Contents

1	Introduction	1
2	How to load Asir/Contrib	3
3	Function Names in Asir Contrib	4
4	Asir-contrib for Windows	5
5	Basic (Standard Functions)	6
5.0.1	base_cancel	6
5.0.2	base_choose	6
5.0.3	base_f_definedp	6
5.0.4	base_flatten	6
5.0.5	base_intersection	6
5.0.6	base_is_asir2018	6
5.0.7	base_is_equal	6
5.0.8	base_ith	7
5.0.9	base_makelist	7
5.0.10	base_memberq	7
5.0.11	base_permutation	7
5.0.12	base_position	7
5.0.13	base_preplace	8
5.0.14	base_product	8
5.0.15	base_prune	8
5.0.16	base_range	8
5.0.17	base_rebuild_opt	8
5.0.18	base_replace	9
5.0.19	base_replace_n	9
5.0.20	base_rest	9
5.0.21	base_set_intersection	9
5.0.22	base_set_minus	9
5.0.23	base_set_union	9
5.0.24	base_subsequenceq	10
5.0.25	base_subsetq	10
5.0.26	base_subsets_of_size	10
5.0.27	base_sum	10
5.0.28	base_var_list	10
6	Numbers (Standard Mathematical Functions) ..	11
6.0.1	number_abs	11
6.0.2	number_ceiling	11

6.0.3	number_eval	11
6.0.4	number_factor	11
6.0.5	number_float_to_rational	11
6.0.6	number_floor	11
6.0.7	number_imaginary_part	12
6.0.8	number_is_integer	12
6.0.9	number_real_part	12
6.0.10	number_setprec	12
7	Calculus (Standard Mathematical Functions) ..	13
8	Series (Standard Mathematical Functions)...	14
9	Special Functions (Standard Mathematical Functions)	15
10	Matrix (Standard Mathematical Functions) ..	16
10.0.1	matrix_adjugate	16
10.0.2	matrix_clone	16
10.0.3	matrix_det	16
10.0.4	matrix_diagonal_matrix	16
10.0.5	matrix_eigenvalues	16
10.0.6	matrix_gauge_transformation	16
10.0.7	matrix_identity_matrix	17
10.0.8	matrix_ij	17
10.0.9	matrix_image	17
10.0.10	matrix_inner_product	17
10.0.11	matrix_inverse	17
10.0.12	matrix_inverse_singular	17
10.0.13	matrix_is_zero	18
10.0.14	matrix_kernel	18
10.0.15	matrix_kronecker_product	18
10.0.16	matrix_list_to_matrix	18
10.0.17	matrix_matrix_to_list	18
10.0.18	matrix_ones	18
10.0.19	matrix_poly_to_matrix	19
10.0.20	matrix_rank	19
10.0.21	matrix_rank_ff	19
10.0.22	matrix_row_matrix	19
10.0.23	matrix_solve_linear	19
10.0.24	matrix_stack	19
10.0.25	matrix_submatrix	20
10.0.26	matrix_transpose	20
11	Graphic (Standard Mathematical Functions) ..	21

12 Print (Standard Mathematical Functions) .. 22

12.0.1	print_c_form.....	22
12.0.2	print_dvi_form.....	22
12.0.3	print_em.....	22
12.0.4	print_format.....	22
12.0.5	print_gif_form.....	23
12.0.6	print_input_form.....	23
12.0.7	print_open_math_tfb_form.....	23
12.0.8	print_open_math_xml_form.....	23
12.0.9	print_output.....	23
12.0.10	print_ox_rfc100_xml_form.....	24
12.0.11	print_pdf_form.....	24
12.0.12	print_png_form.....	24
12.0.13	print_terminal_form.....	24
12.0.14	print_tex_form.....	25
12.0.15	print_tfb_form.....	25
12.0.16	print_xdvi_form.....	25
12.0.17	print_xv_form.....	25

13 Polynomials (Standard Mathematical Functions) 27

13.0.1	poly_coefficient.....	27
13.0.2	poly_coefficients_list.....	27
13.0.3	poly_coefficients_of_monomial_list.....	27
13.0.4	poly_construct_from_coefficients_of_monomial_list..	27
13.0.5	poly_dact.....	28
13.0.6	poly_decompose_by_weight.....	28
13.0.7	poly_degree.....	28
13.0.8	poly_denominator.....	28
13.0.9	poly_diff2euler.....	28
13.0.10	poly_dmul.....	29
13.0.11	poly_dvar.....	29
13.0.12	poly_elimination_ideal.....	29
13.0.13	poly_euler2diff.....	29
13.0.14	poly_expand.....	30
13.0.15	poly_factor.....	30
13.0.16	poly_gcd.....	30
13.0.17	poly_gr_w.....	30
13.0.18	poly_grobner_basis.....	30
13.0.19	poly_hilbert_polynomial.....	31
13.0.20	poly_ideal_colon.....	31
13.0.21	poly_ideal_intersection.....	31
13.0.22	poly_ideal_saturation.....	31
13.0.23	poly_in.....	32
13.0.24	poly_in_w.....	32
13.0.25	poly_in_w_.....	32
13.0.26	poly_initial.....	33

13.0.27	poly_initial_coefficients	33
13.0.28	poly_initial_term	33
13.0.29	poly_lcm	33
13.0.30	poly_numerator	34
13.0.31	poly_ord_w	34
13.0.32	poly_prime_dec	34
13.0.33	poly_r_omatrix	34
13.0.34	poly_replace_factor	35
13.0.35	poly_solve_linear	35
13.0.36	poly_sort	35
13.0.37	poly_subsetq	35
13.0.38	poly_toric_ideal	35
13.0.39	poly_w_marking	36
13.0.40	poly_weight_to_omatrix	36
13.0.41	poly_weight_to_ord_matrix	36
13.0.42	poly_weyl_subsetq	36
14	Complex (Standard Mathematical Functions) ..	38
15	Graphic Library (2 dimensional)	39
15.0.1	glib_clear	39
15.0.2	glib_flush	39
15.0.3	glib_line	39
15.0.4	glib_open	39
15.0.5	glib_plot	39
15.0.6	glib_print	39
15.0.7	glib_ps_form	40
15.0.8	glib_putpixel	40
15.0.9	glib_remove_last	40
15.0.10	glib_set_pixel_size	40
15.0.11	glib_tops	40
15.0.12	glib_window	40
16	OpenXM-Contrib General Functions	41
16.1	Functions	41
16.1.1	ox_check_errors2	41
17	OXshell Functions	42
17.0.1	oxshell.get_value	42
17.0.2	oxshell.oxshell	42
17.0.3	oxshell.set_value	42
18	Asir System Utility Functions	43
18.0.1	asir_contrib_update	43

19	Utility Functions	44
19.0.1	util_damepathq	44
19.0.2	util_file_exists	44
19.0.3	util_filter	44
19.0.4	util_find_and_replace	44
19.0.5	util_find_start	44
19.0.6	util_find_substr	44
19.0.7	util_index	45
19.0.8	util_load_file_as_a_string	45
19.0.9	util_part	45
19.0.10	util_read_file_as_a_string	45
19.0.11	util_remove_cr	45
19.0.12	util_timing	45
19.0.13	util_v	45
19.0.14	util_write_string_to_a_file	45
20	Other Manuals	46
20.0.1	dsolv (Solving the initial ideal for holonomic systems)	46
20.0.2	gtt_ekn (Two way contingency tables by HGM)	46
20.0.3	f_res (Comuting resultant)	46
20.0.4	(gnuplot ox server for graphics)	46
20.0.5	mathematica (Mathematica (TM) ox server)	46
20.0.6	mt_graph (3D grapher)	46
20.0.7	mt_gkz (Intersection matrix of GKZ systems)	46
20.0.8	mt_mm (Macaulay matrix method)	46
20.0.9	n_wishartd (restriction of matrix 1F1)	46
20.0.10	nn_ndbf (local b-function)	46
20.0.11	noro_mwl (Mordel Weil Lattice)	46
20.0.12	noro_module_syz (syzygies for modules)	46
20.0.13	ns_twistedlog (twisted logarithmic cohomology group)	46
20.0.14	nk_fb_gen_c (Fisher Bingham MLE)	47
20.0.15	ok_diff (Okutani's library for differential operators)	47
20.0.16	ok_dmodule (Okutani's library for D-modules)	47
20.0.17	om (om (java) ox server for translating CMO and OpenMath)	47
20.0.18	ox_pari (OpenXM pari server)	47
20.0.19	(Plucker relations)	47
20.0.20	pfpcoh (Ohara's library for homology/cohomology groups for $p \mid F \mid q$)	47
20.0.21	phc (PHC ox server for solving systems of algebraic equations by the homotopy method)	47
20.0.22	sm1 (Kan/sm1 ox server for the ring of differential operators)	47
20.0.23	tigers (tigers ox server for toric universal Grobner bases)	47
20.0.24	tk_ode_by_mpr (Generating C codes for numerical analysis of ODE by MPFR, document in Japanese)	47
20.0.25	[[todo_parametrize]]	47
20.0.26	taji_alc	48

20.0.27	Manual and papers which are not written in texinfo.	48
---------	--	----

Index	49
--------------	-------	-----------

