RingsForHomalg

Dictionaries of External Rings for the GAP Package homalg

Version 2016.01.20

September 2015

Mohamed Barakat

Simon Goertzen

Markus Kirschmer

Markus Lange-Hegermann

Oleksandr Motsak

Max Neunhöffer

Daniel Robertz

Hans Schönemann

Andreas Steenpaß

Vinay Wagh

(*this manual is still under construction*)

This manual is best viewed as an HTML document. The latest version is available ONLINE at:

http://homalg.math.rwth-aachen.de/~barakat/homalg-project/RingsForHomalg/chap0.html

An OFFLINE version should be included in the documentation subfolder of the package. This package is part of the homalg-project:

http://homalg.math.rwth-aachen.de/index.php/core-packages/ringsforhomalg

Mohamed Barakat
Email: barakat@mathematik.uni-kl.de
Homepage: http://www.mathematik.uni-kl.de/~barakat/
Address: Department of Mathematics,
University of Kaiserslautern,
67653 Kaiserslautern,
Germany

Simon Goertzen
Email: simon.goertzen@rwth-aachen.de
Homepage: http://wwwb.math.rwth-aachen.de/~simon/
Address: Lehrstuhl B für Mathematik,
RWTH Aachen,
Templergraben 64,
52056 Aachen,
Germany

Markus Kirschmer
Email: markus.kirschmer@math.rwth-aachen.de
Homepage: http://www.math.rwth-aachen.de/~Markus.Kirschmer/
Address: Lehrstuhl D für Mathematik,
RWTH Aachen,
Templergraben 64,
52056 Aachen,
Germany

Markus Lange-Hegermann
Email: markus.lange-hegermann@rwth-aachen.de
Homepage: http://wwwb.math.rwth-aachen.de/~markus/
Address: Lehrstuhl B für Mathematik,
RWTH Aachen,
Templergraben 64,
52056 Aachen,
Germany

Oleksandr Motsak
Email: motsak@mathematik.uni-kl.de
Homepage: http://www.mathematik.uni-kl.de/~motsak/

Address: Department of Mathematics,
University of Kaiserslautern,
67653 Kaiserslautern,
Germany

Max Neunhöffer

Email: neunhoef@mcs.st-and.ac.uk

Homepage: http://www-groups.mcs.st-and.ac.uk/~neunhoef/

Address: St Andrews University,
School of Mathematics and Statistics,
Mathematical Institute,
North Haugh,
St Andrews, Fife KY16 9SS,
Scotland, UK

Daniel Robertz

Email: daniel@momo.math.rwth-aachen.de

Homepage: http://wwwb.math.rwth-aachen.de/~daniel

Address: Lehrstuhl B für Mathematik,
RWTH Aachen,
Templergraben 64,
52056 Aachen,
Germany

Hans Schönemann

Email: hannes@mathematik.uni-kl.de

Homepage: http://www.mathematik.uni-kl.de/~hannes/

Address: Department of Mathematics,
University of Kaiserslautern,
67653 Kaiserslautern,
Germany

Andreas Steenpaß

Email: steenpass@mathematik.uni-kl.de

Homepage:

Address: Department of Mathematics,
University of Kaiserslautern,
67653 Kaiserslautern,
Germany

Vinay Wagh

Email: waghoba@gmail.com

Homepage: http://www.iitg.ernet.in/vinay.wagh/

Address: E-102, Department of Mathematics,
Indian Institute of Technology Guwahati,
Guwahati, Assam, India.
PIN: 781 039.

Copyright

Contents

Chapter 1

Introduction

This package is part of the homalg project [hpa10]. The role of the package is described in the manual of the homalg package.

1.1 Ring Constructions for Supported External Computer Algebra Systems

Here are some of the supported ring constructions:

1.1.1 external GAP

Example

```
gap> ZZ := HomalgRingOfIntegersInExternalGAP( );
Z
gap> Display( ZZ );
<An external ring residing in the CAS GAP>
gap> F2 := HomalgRingOfIntegersInExternalGAP( 2, ZZ );
GF(2)
gap> Display( F2 );
<An external ring residing in the CAS GAP>
```

`F2 := HomalgRingOfIntegersInExternalGAP( 2 )` would launch another GAP.

Example

```
gap> Z4 := HomalgRingOfIntegersInExternalGAP( 4, ZZ );
Z/4Z
gap> Display( Z4 );
<An external ring residing in the CAS GAP>
gap> Z_4 := HomalgRingOfIntegersInExternalGAP( ZZ ) / 4;
Z/( 4 )
gap> Display( Z_4 );
<A residue class ring>
gap> Q := HomalgFieldOfRationalsInExternalGAP( ZZ );
Q
gap> Display( Q );
<An external ring residing in the CAS GAP>
```

1.1.2 Singular

Example

```
gap> F2 := HomalgRingOfIntegersInSingular( 2 );
GF(2)
gap> Display( F2 );
<An external ring residing in the CAS Singular>
gap> F2s := HomalgRingOfIntegersInSingular( 2, "s" ,F2 );
GF(2)(s)
gap> Display( F2s );
<An external ring residing in the CAS Singular>
gap> ZZ := HomalgRingOfIntegersInSingular( F2 );
Z
gap> Display( ZZ );
<An external ring residing in the CAS Singular>
gap> Q := HomalgFieldOfRationalsInSingular( F2 );
Q
gap> Display( Q );
<An external ring residing in the CAS Singular>
gap> Qs := HomalgFieldOfRationalsInSingular( "s", F2 );
Q(s)
gap> Display( Qs );
<An external ring residing in the CAS Singular>
gap> Qi := HomalgFieldOfRationalsInSingular( "i", "i^2+1", Q );
Q[i]/(i^2+1)
gap> Display( Qi );
<An external ring residing in the CAS Singular>
```

`Q := HomalgFieldOfRationalsInSingular( )` would launch another Singular.

Example

```
gap> F2xyz := F2 * "x,y,z";
GF(2)[x,y,z]
gap> Display( F2xyz );
<An external ring residing in the CAS Singular>
gap> F2sxyz := F2s * "x,y,z";
GF(2)(s)[x,y,z]
gap> Display( F2sxyz );
<An external ring residing in the CAS Singular>
gap> F2xyzw := F2xyz * "w";
GF(2)[x,y,z][w]
gap> Display( F2xyzw );
<An external ring residing in the CAS Singular>
gap> F2sxyzw := F2sxyz * "w";
GF(2)(s)[x,y,z][w]
gap> Display( F2sxyzw );
<An external ring residing in the CAS Singular>
gap> ZZxyz := ZZ * "x,y,z";
Z[x,y,z]
gap> Display( ZZxyz );
<An external ring residing in the CAS Singular>
gap> ZZxyzw := ZZxyz * "w";
Z[x,y,z][w]
gap> Display( ZZxyzw );
<An external ring residing in the CAS Singular>
```

```
gap> Qxyz := Q * "x,y,z";
Q[x,y,z]
gap> Display( Qxyz );
<An external ring residing in the CAS Singular>
gap> Qsxyz := Qs * "x,y,z";
Q(s)[x,y,z]
gap> Display( Qsxyz );
<An external ring residing in the CAS Singular>
gap> Qixyz := Qi * "x,y,z";
(Q[i]/(i^2+1))[x,y,z]
gap> Display( Qixyz );
<An external ring residing in the CAS Singular>
gap> Qxyzw := Qxyz * "w";
Q[x,y,z][w]
gap> Display( Qxyzw );
<An external ring residing in the CAS Singular>
gap> Qsxyzw := Qsxyz * "w";
Q(s)[x,y,z][w]
gap> Display( Qsxyzw );
<An external ring residing in the CAS Singular>
gap> Dxyz := RingOfDerivations( Qxyz, "Dx,Dy,Dz" );
Q[x,y,z]<Dx,Dy,Dz>
gap> Display( Dxyz );
<An external ring residing in the CAS Singular>
gap> Exyz := ExteriorRing( Qxyz, "e,f,g" );
Q{e,f,g}
gap> Display( Exyz );
<An external ring residing in the CAS Singular>
gap> Dsxyz := RingOfDerivations( Qsxyz, "Dx,Dy,Dz" );
Q(s)[x,y,z]<Dx,Dy,Dz>
gap> Display( Dsxyz );
<An external ring residing in the CAS Singular>
gap> Esxyz := ExteriorRing( Qsxyz, "e,f,g" );
Q(s){e,f,g}
gap> Display( Esxyz );
<An external ring residing in the CAS Singular>
gap> Dixyz := RingOfDerivations( Qixyz, "Dx,Dy,Dz" );
(Q[i]/(i^2+1))[x,y,z]<Dx,Dy,Dz>
gap> Display( Dixyz );
<An external ring residing in the CAS Singular>
gap> Eixyz := ExteriorRing( Qixyz, "e,f,g" );
(Q[i]/(i^2+1)){e,f,g}
gap> Display( Eixyz );
<An external ring residing in the CAS Singular>
```

1.1.3 MAGMA

Example

```
gap> ZZ := HomalgRingOfIntegersInMAGMA( );
Z
gap> Display( ZZ );
<An external ring residing in the CAS MAGMA>
gap> F2 := HomalgRingOfIntegersInMAGMA( 2, ZZ );
```

```
GF(2)
gap> Display( F2 );
<An external ring residing in the CAS MAGMA>
```

`F2 := HomalgRingOfIntegersInMAGMA( 2 )` would launch another MAGMA.

Example

```
gap> Z_4 := HomalgRingOfIntegersInMAGMA( ZZ ) / 4;
Z/( 4 )
gap> Display( Z_4 );
<A residue class ring>
gap> Q := HomalgFieldOfRationalsInMAGMA( ZZ );
Q
gap> Display( Q );
<An external ring residing in the CAS MAGMA>
gap> F2xyz := F2 * "x,y,z";
GF(2)[x,y,z]
gap> Display( F2xyz );
<An external ring residing in the CAS MAGMA>
gap> Qxyz := Q * "x,y,z";
Q[x,y,z]
gap> Display( Qxyz );
<An external ring residing in the CAS MAGMA>
gap> Exyz := ExteriorRing( Qxyz, "e,f,g" );
Q{e,f,g}
gap> Display( Exyz );
<An external ring residing in the CAS MAGMA>
```

1.1.4 Macaulay2

Example

```
gap> ZZ := HomalgRingOfIntegersInMacaulay2( );
Z
gap> Display( ZZ );
<An external ring residing in the CAS Macaulay2>
gap> F2 := HomalgRingOfIntegersInMacaulay2( 2, ZZ );
GF(2)
gap> Display( F2 );
<An external ring residing in the CAS Macaulay2>
```

`F2 := HomalgRingOfIntegersInMacaulay2( 2 )` would launch another Macaulay2.

Example

```
gap> Z_4 := HomalgRingOfIntegersInMacaulay2( ZZ ) / 4;
Z/( 4 )
gap> Display( Z_4 );
<A residue class ring>
gap> Q := HomalgFieldOfRationalsInMacaulay2( ZZ );
Q
gap> Display( Q );
<An external ring residing in the CAS Macaulay2>
gap> F2xyz := F2 * "x,y,z";
GF(2)[x,y,z]
gap> Display( F2xyz );
```

```
<An external ring residing in the CAS Macaulay2>
gap> Qxyz := Q * "x,y,z";
Q[x,y,z]
gap> Display( Qxyz );
<An external ring residing in the CAS Macaulay2>
gap> Dxyz := RingOfDerivations( Qxyz, "Dx,Dy,Dz" );
Q[x,y,z]<Dx,Dy,Dz>
gap> Display( Dxyz );
<An external ring residing in the CAS Macaulay2>
gap> Exyz := ExteriorRing( Qxyz, "e,f,g" );
Q{e,f,g}
gap> Display( Exyz );
<An external ring residing in the CAS Macaulay2>
```

1.1.5 Sage

Example

```
gap> ZZ := HomalgRingOfIntegersInSage( );
Z
gap> Display( ZZ );
<An external ring residing in the CAS Sage>
gap> F2 := HomalgRingOfIntegersInSage( 2, ZZ );
GF(2)
gap> Display( F2 );
<An external ring residing in the CAS Sage>
```

`F2 := HomalgRingOfIntegersInSage( 2 )` would launch another Sage.

Example

```
gap> Z_4 := HomalgRingOfIntegersInSage( ZZ ) / 4;
Z/( 4 )
gap> Display( Z_4 );
<A residue class ring>
gap> Q := HomalgFieldOfRationalsInSage( ZZ );
Q
gap> Display( Q );
<An external ring residing in the CAS Sage>
gap> F2x := F2 * "x";
GF(2)[x]
gap> Display( F2x );
<An external ring residing in the CAS Sage>
gap> Qx := Q * "x";
Q[x]
gap> Display( Qx );
<An external ring residing in the CAS Sage>
```

1.1.6 Maple

Example

```
gap> ZZ := HomalgRingOfIntegersInMaple( );
Z
gap> Display( ZZ );
<An external ring residing in the CAS Maple>
gap> F2 := HomalgRingOfIntegersInMaple( 2, ZZ );
```

```
GF(2)
gap> Display( F2 );
<An external ring residing in the CAS Maple>
```

`F2 := HomalgRingOfIntegersInMaple( 2 )` would launch another Maple.

Example

```
gap> Z4 := HomalgRingOfIntegersInMaple( 4, ZZ );
Z/4Z
gap> Display( Z4 );
<An external ring residing in the CAS Maple>
gap> Z_4 := HomalgRingOfIntegersInMaple( ZZ ) / 4;
Z/( 4 )
gap> Display( Z_4 );
<A residue class ring>
gap> Q := HomalgFieldOfRationalsInMaple( ZZ );
Q
gap> Display( Q );
<An external ring residing in the CAS Maple>
gap> F2xyz := F2 * "x,y,z";
GF(2)[x,y,z]
gap> Display( F2xyz );
<An external ring residing in the CAS Maple>
gap> Qxyz := Q * "x,y,z";
Q[x,y,z]
gap> Display( Qxyz );
<An external ring residing in the CAS Maple>
gap> Dxyz := RingOfDerivations( Qxyz, "Dx,Dy,Dz" );
Q[x,y,z]<Dx,Dy,Dz>
gap> Display( Dxyz );
<An external ring residing in the CAS Maple>
gap> Exyz := ExteriorRing( Qxyz, "e,f,g" );
Q{e,f,g}
gap> Display( Exyz );
<An external ring residing in the CAS Maple>
```

Chapter 2

Installation of the RingsForHomalg Package

To install this package just extract the package's archive file to the GAP `pkg` directory.

By default the RingsForHomalg package is not automatically loaded by GAP when it is installed. You must load the package with

```
LoadPackage( "RingsForHomalg" );
```

before its functions become available.

Please, send us an e-mail if you have any questions, remarks, suggestions, etc. concerning this package. Also, we would be pleased to hear about applications of this package.

The authors.

Chapter 3

The Ring Table

3.1 An Example for a Ring Table - Singular

todo: introductory text, mention: transposed matrices, the macros, refer to the philosophy

3.1.1 BasisOfRowModule (in the homalg table for Singular)

▷ `BasisOfRowModule(`*M*`)` (function)

Returns:

This is the entry of the homalg table, which calls the corresponding macro `BasisOfRowModule` (3.1.2) inside the computer algebra system.

Code

```
BasisOfRowModule :=
  function( M )
    local N;

    N := HomalgVoidMatrix(
      "unknown_number_of_rows",
      NrColumns( M ),
      HomalgRing( M )
    );

    homalgSendBlocking(
      [ "matrix ", N, " = BasisOfRowModule(", M, ")" ],
      "need_command",
      HOMALG_IO.Pictograms.BasisOfModule
    );

    return N;

  end,
```

3.1.2 BasisOfRowModule (Singular macro)

▷ `BasisOfRowModule(`*M*`)` (function)

Returns:

Code

```
    BasisOfRowModule := "\n\
proc BasisOfRowModule (matrix M)\n\
{\n\
  return(std(M));\n\
}\n\n",
```

3.1.3 BasisOfColumnModule (in the homalg table for Singular)

▷ BasisOfColumnModule(*M*) (function)

Returns:

This is the entry of the homalg table, which calls the corresponding macro BasisOfColumnModule (3.1.4) inside the computer algebra system.

Code

```
BasisOfColumnModule :=
  function( M )
    local N;

    N := HomalgVoidMatrix(
      NrRows( M ),
      "unknown_number_of_columns",
      HomalgRing( M )
    );

    homalgSendBlocking(
      [ "matrix ", N, " = BasisOfColumnModule(", M, ")" ],
      "need_command",
      HOMALG_IO.Pictograms.BasisOfModule
    );

    return N;

  end,
```

3.1.4 BasisOfColumnModule (Singular macro)

▷ BasisOfColumnModule(*M*) (function)

Returns:

Code

```
    BasisOfColumnModule := "\n\
proc BasisOfColumnModule (matrix M)\n\
{\n\
  return(Involution(BasisOfRowModule(Involution(M))));\n\
}\n\n",
```

3.1.5 DecideZeroRows (in the homalg table for Singular)

▷ DecideZeroRows(*A*, *B*) (function)

Returns:

This is the entry of the homalg table, which calls the corresponding macro DecideZeroRows (3.1.6) inside the computer algebra system.

Code

```
DecideZeroRows :=
  function( A, B )
    local N;

    N := HomalgVoidMatrix(
      NrRows( A ),
      NrColumns( A ),
      HomalgRing( A )
    );

    homalgSendBlocking(
      [ "matrix ", N, " = DecideZeroRows(", A, B, ")" ],
      "need_command",
      HOMALG_IO.Pictograms.DecideZero
    );

    return N;

  end,
```

3.1.6 DecideZeroRows (Singular macro)

▷ DecideZeroRows(*A*, *B*) (function)

Returns:

Code

```
    DecideZeroRows := "\n\
proc DecideZeroRows (matrix A, module B)\n\
{\n\
  attrib(B,\"isSB\",1);\n\
  return(reduce(A,B));\n\
}\n\n",
```

3.1.7 DecideZeroColumns (in the homalg table for Singular)

▷ DecideZeroColumns(*A*, *B*) (function)

Returns:

This is the entry of the homalg table, which calls the corresponding macro DecideZeroColumns (3.1.8) inside the computer algebra system.

Code

```
DecideZeroColumns :=
  function( A, B )
    local N;

    N := HomalgVoidMatrix(
      NrRows( A ),
      NrColumns( A ),
      HomalgRing( A )
    );
```

```
    homalgSendBlocking(
      [ "matrix ", N, " = DecideZeroColumns(", A, B, ")" ],
      "need_command",
      HOMALG_IO.Pictograms.DecideZero
    );

    return N;

  end,
```

3.1.8 DecideZeroColumns (Singular macro)

▷ DecideZeroColumns(*A*, *B*) (function)

Returns:

Code

```
    DecideZeroColumns := "\n\
proc DecideZeroColumns (matrix A, matrix B)\n\
{\n\
  return(Involution(DecideZeroRows(Involution(A),Involution(B))));\n\
}\n\n",
```

3.1.9 SyzygiesGeneratorsOfRows (in the homalg table for Singular)

▷ SyzygiesGeneratorsOfRows(*M*) (function)

Returns:

This is the entry of the homalg table, which calls the corresponding macro SyzygiesGeneratorsOfRows (3.1.10) inside the computer algebra system.

Code

```
SyzygiesGeneratorsOfRows :=
  function( M )
    local N;

    N := HomalgVoidMatrix(
      "unknown_number_of_rows",
      NrRows( M ),
      HomalgRing( M )
    );

    homalgSendBlocking(
      [ "matrix ", N, " = SyzygiesGeneratorsOfRows(", M, ")" ],
      "need_command",
      HOMALG_IO.Pictograms.SyzygiesGenerators
    );

    return N;

  end,
```

3.1.10 SyzygiesGeneratorsOfRows (Singular macro)

▷ SyzygiesGeneratorsOfRows(*M*) (function)

Returns:

Code

```
    SyzygiesGeneratorsOfRows := "\n\
proc SyzygiesGeneratorsOfRows (matrix M)\n\
{\n\
  return(SyzForHomalg(M));\n\
}\n\n",
```

3.1.11 SyzygiesGeneratorsOfColumns (in the homalg table for Singular)

▷ SyzygiesGeneratorsOfColumns(*M*) (function)

Returns:

This is the entry of the homalg table, which calls the corresponding macro SyzygiesGeneratorsOfColumns (3.1.12) inside the computer algebra system.

Code

```
SyzygiesGeneratorsOfColumns :=
  function( M )
    local N;

    N := HomalgVoidMatrix(
      NrColumns( M ),
      "unknown_number_of_columns",
      HomalgRing( M )
    );

    homalgSendBlocking(
      [ "matrix ", N, " = SyzygiesGeneratorsOfColumns(", M, ")" ],
      "need_command",
      HOMALG_IO.Pictograms.SyzygiesGenerators
    );

    return N;

  end,
```

3.1.12 SyzygiesGeneratorsOfColumns (Singular macro)

▷ SyzygiesGeneratorsOfColumns(*M*) (function)

Returns:

Code

```
    SyzygiesGeneratorsOfColumns := "\n\
proc SyzygiesGeneratorsOfColumns (matrix M)\n\
{\n\
  return(Involution(SyzForHomalg(Involution(M))));\n\
}\n\n",
```

3.1.13 BasisOfRowsCoeff (in the homalg table for Singular)

▷ `BasisOfRowsCoeff(M, T)` (function)

Returns:

This is the entry of the homalg table, which calls the corresponding macro `BasisOfRowsCoeff` (3.1.14) inside the computer algebra system.

Code

```
BasisOfRowsCoeff :=
  function( M, T )
    local v, N;

    v := homalgStream( HomalgRing( M ) )!.variable_name;

    N := HomalgVoidMatrix(
      "unknown_number_of_rows",
      NrColumns( M ),
      HomalgRing( M )
    );

    homalgSendBlocking(
      [
        "list ", v, "l=BasisOfRowsCoeff(", M, "); ",
        "matrix ", N, " = ", v, "l[1]; ",
        "matrix ", T, " = ", v, "l[2]"
      ],
      "need_command",
      HOMALG_IO.Pictograms.BasisCoeff
    );

    return N;

  end,
```

3.1.14 BasisOfRowsCoeff (Singular macro)

▷ `BasisOfRowsCoeff(M, T)` (function)

Returns:

Code

```
    BasisOfRowsCoeff := "\n\
proc BasisOfRowsCoeff (matrix M)\n\
{\n\
  matrix B = BasisOfRowModule(M);\n\
  matrix T = lift(M,B);\n\
  list l = B,T;\n\
  return(l)\n\
}\n\n",
```

3.1.15 BasisOfColumnsCoeff (in the homalg table for Singular)

▷ `BasisOfColumnsCoeff(M, T)` (function)

Returns:

This is the entry of the homalg table, which calls the corresponding macro BasisOfColumnsCoeff (3.1.16) inside the computer algebra system.

Code

```
BasisOfColumnsCoeff :=
  function( M, T )
    local v, N;

    v := homalgStream( HomalgRing( M ) )!.variable_name;

    N := HomalgVoidMatrix(
      NrRows( M ),
      "unknown_number_of_columns",
      HomalgRing( M )
    );

    homalgSendBlocking(
      [
        "list ", v, "l=BasisOfColumnsCoeff(", M, "); ",
        "matrix ", N, " = ", v, "l[1]; ",
        "matrix ", T, " = ", v, "l[2]"
      ],
      "need_command",
      HOMALG_IO.Pictograms.BasisCoeff
    );

    return N;

  end,
```

3.1.16 BasisOfColumnsCoeff (Singular macro)

▷ BasisOfColumnsCoeff(*M, T*) (function)

Returns:

Code

```
    BasisOfColumnsCoeff := "\n\
proc BasisOfColumnsCoeff (matrix M)\n\
{\n\
  list l = BasisOfRowsCoeff(Involution(M));\n\
  matrix B = l[1];\n\
  matrix T = l[2];\n\
  l = Involution(B),Involution(T);\n\
  return(l);\n\
}\n\n",
```

3.1.17 DecideZeroRowsEffectively (in the homalg table for Singular)

▷ DecideZeroRowsEffectively(*A, B, T*) (function)

Returns:

This is the entry of the homalg table, which calls the corresponding macro DecideZeroRowsEffectively (3.1.18) inside the computer algebra system.

Code

```
DecideZeroRowsEffectively :=
  function( A, B, T )
    local v, N;

    v := homalgStream( HomalgRing( A ) )!.variable_name;

    N := HomalgVoidMatrix(
      NrRows( A ),
      NrColumns( A ),
      HomalgRing( A )
    );

    homalgSendBlocking(
      [
        "list ", v, "l=DecideZeroRowsEffectively(", A, B, "); ",
        "matrix ", N, " = ", v, "l[1]; ",
        "matrix ", T, " = ", v, "l[2]"
      ],
      "need_command",
      HOMALG_IO.Pictograms.DecideZeroEffectively
    );

    return N;

  end,
```

3.1.18 DecideZeroRowsEffectively (Singular macro)

▷ DecideZeroRowsEffectively(*A, B, T*) (function)

Returns:

Code

```
    DecideZeroRowsEffectively := "\n\
proc DecideZeroRowsEffectively (matrix A, module B)\n\
{\n\
  attrib(B,\"isSB\",1);\n\
  matrix M = reduce(A,B);\n\
  matrix T = lift(B,M-A);\n\
  list l = M,T;\n\
  return(l);\n\
}\n\n",
```

3.1.19 DecideZeroColumnsEffectively (in the homalg table for Singular)

▷ DecideZeroColumnsEffectively(*A, B, T*) (function)

Returns:

This is the entry of the homalg table, which calls the corresponding macro DecideZeroColumnsEffectively (3.1.20) inside the computer algebra system.

Code

```
DecideZeroColumnsEffectively :=
  function( A, B, T )
```

```
    local v, N;

    v := homalgStream( HomalgRing( A ) )!.variable_name;

    N := HomalgVoidMatrix(
      NrRows( A ),
      NrColumns( A ),
      HomalgRing( A )
    );

    homalgSendBlocking(
      [
        "list ", v, "l=DecideZeroColumnsEffectively(", A, B, "); ",
        "matrix ", N, " = ", v, "l[1]; ",
        "matrix ", T, " = ", v, "l[2]"
      ],
      "need_command",
      HOMALG_IO.Pictograms.DecideZeroEffectively
    );

    return N;

  end,
```

3.1.20 DecideZeroColumnsEffectively (Singular macro)

▷ DecideZeroColumnsEffectively(*A, B, T*) (function)

Returns:

Code

```
    DecideZeroColumnsEffectively := "\n\
proc DecideZeroColumnsEffectively (matrix A, matrix B)\n\
{\n\
  list l = DecideZeroRowsEffectively(Involution(A),Involution(B));\n\
  matrix B = l[1];\n\
  matrix T = l[2];\n\
  l = Involution(B),Involution(T);\n\
  return(l);\n\
}\n\n",
```

3.1.21 RelativeSyzygiesGeneratorsOfRows (in the homalg table for Singular)

▷ RelativeSyzygiesGeneratorsOfRows(*M, M2*) (function)

Returns:

This is the entry of the homalg table, which calls the corresponding macro RelativeSyzygiesGeneratorsOfRows (3.1.22) inside the computer algebra system.

Code

```
RelativeSyzygiesGeneratorsOfRows :=
  function( M, M2 )
    local N;

    N := HomalgVoidMatrix(
```

```
      "unknown_number_of_rows",
      NrRows( M ),
      HomalgRing( M )
    );

    homalgSendBlocking(
      [ "matrix ", N, " = RelativeSyzygiesGeneratorsOfRows(", M, M2, ")" ],
      "need_command",
      HOMALG_IO.Pictograms.SyzygiesGenerators
    );

    return N;

  end,
```

3.1.22 RelativeSyzygiesGeneratorsOfRows (Singular macro)

▷ RelativeSyzygiesGeneratorsOfRows(*M, M2*) (function)

Returns:

Code

```
    RelativeSyzygiesGeneratorsOfRows := "\n\
proc RelativeSyzygiesGeneratorsOfRows (matrix M1, matrix M2)\n\
{\n\
  return(BasisOfRowModule(modulo(M1, M2)));\n\
}\n\n",
```

3.1.23 RelativeSyzygiesGeneratorsOfColumns (in the homalg table for Singular)

▷ RelativeSyzygiesGeneratorsOfColumns(*M, M2*) (function)

Returns:

This is the entry of the homalg table, which calls the corresponding macro RelativeSyzygiesGeneratorsOfColumns (3.1.24) inside the computer algebra system.

Code

```
RelativeSyzygiesGeneratorsOfColumns :=
  function( M, M2 )
    local N;

    N := HomalgVoidMatrix(
      NrColumns( M ),
      "unknown_number_of_columns",
      HomalgRing( M )
    );

    homalgSendBlocking(
      [ "matrix ", N, " = RelativeSyzygiesGeneratorsOfColumns(", M, M2, ")" ],
      "need_command",
      HOMALG_IO.Pictograms.SyzygiesGenerators
    );

    return N;
```

```
    end,
```

3.1.24 RelativeSyzygiesGeneratorsOfColumns (Singular macro)

▷ RelativeSyzygiesGeneratorsOfColumns(*M, M2*) (function)

Returns:

Code

```
      RelativeSyzygiesGeneratorsOfColumns := "\n\
  proc RelativeSyzygiesGeneratorsOfColumns (matrix M1, matrix M2)\n\
  {\n\
    return(Involution(RelativeSyzygiesGeneratorsOfRows(Involution(M1),Involution(M2))));\n\
  }\n\n",
```

3.1.25 ReducedSyzygiesGeneratorsOfRows (in the homalg table for Singular)

▷ ReducedSyzygiesGeneratorsOfRows(*M*) (function)

Returns:

This is the entry of the homalg table, which calls the corresponding macro ReducedSyzygiesGeneratorsOfRows (3.1.26) inside the computer algebra system.

Code

```
  ReducedSyzygiesGeneratorsOfRows :=
    function( M )
      local N;

      N := HomalgVoidMatrix(
        "unknown_number_of_rows",
        NrRows( M ),
        HomalgRing( M )
      );

      homalgSendBlocking(
        [ "matrix ", N, " = ReducedSyzygiesGeneratorsOfRows(", M, ")" ],
        "need_command",
        HOMALG_IO.Pictograms.SyzygiesGenerators
      );

      return N;

    end,
```

3.1.26 ReducedSyzygiesGeneratorsOfRows (Singular macro)

▷ ReducedSyzygiesGeneratorsOfRows(*M*) (function)

Returns:

Code

```
      ReducedSyzForHomalg := "\n\
  proc ReducedSyzForHomalg (matrix M)\n\
  {\n\
    return(matrix(nres(M,2)[2]));\n\
```

```
}\n\n",
    ReducedSyzygiesGeneratorsOfRows := "\n\
proc ReducedSyzygiesGeneratorsOfRows (matrix M)\n\
{\n\
  return(ReducedSyzForHomalg(M));\n\
}\n\n",
```

3.1.27 ReducedSyzygiesGeneratorsOfColumns (in the homalg table for Singular)

▷ ReducedSyzygiesGeneratorsOfColumns(*M*) (function)

Returns:

This is the entry of the homalg table, which calls the corresponding macro ReducedSyzygiesGeneratorsOfColumns (3.1.28) inside the computer algebra system.

Code

```
ReducedSyzygiesGeneratorsOfColumns :=
  function( M )
    local N;

    N := HomalgVoidMatrix(
      NrColumns( M ),
      "unknown_number_of_columns",
      HomalgRing( M )
    );

    homalgSendBlocking(
      [ "matrix ", N, " = ReducedSyzygiesGeneratorsOfColumns(", M, ")" ],
      "need_command",
      HOMALG_IO.Pictograms.SyzygiesGenerators
    );

    return N;

  end,
```

3.1.28 ReducedSyzygiesGeneratorsOfColumns (Singular macro)

▷ ReducedSyzygiesGeneratorsOfColumns(*M*) (function)

Returns:

Code

```
    ReducedSyzygiesGeneratorsOfColumns := "\n\
proc ReducedSyzygiesGeneratorsOfColumns (matrix M)\n\
{\n\
  return(Involution(ReducedSyzForHomalg(Involution(M))));\n\
}\n\n",
```

References

[hpa10] T. homalg project authors. *The homalg project*, 2003-2010. http://homalg.math.rwth-aachen.de/. 4

Index