

FPLSA

A GAP4 Package
For Finitely Presented Lie Super Algebras
Version 1.0

by

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1

The FPLSA Package

This chapter describes the FPLSA package, an interface to the `fplsa` program by V. Gerdt and V. Kornyak (version 4) for the computation with finitely presented Lie superalgebras.

At present GAP uses only the facility to compute a structure constants table of a finite-dimensional Lie algebra over the rationals that is given by a finite presentation.

As the package uses an external binary, it will only work on UNIX platforms.

1.1 Main Functions

A finitely-presented Lie algebra is a quotient of a free Lie algebra by an ideal generated by a finite number of elements. In GAP a free Lie algebra can be created by the command `FreeLieAlgebra`; we refer to the reference manual for more details. A finitely presented Lie algebra K can be constructed by $K := L/\text{rels}$, where L is a free Lie algebra and rels a list of elements of L that constitute the relations that hold in K . Given a finitely presented Lie algebra we want to calculate a basis and a multiplication table of it. The interface to the FPLSA package comes with two related functions for doing that.

1 ► `SCAlgebraInfoOfFpLieAlgebra(L, rels, limit, words, rels)` F

Let L be a free Lie algebra over the rationals, rels a list of elements in L , limit a positive integer and words and rels two booleans.

If the algebra L / rels is finite-dimensional and if a basis of this algebra can be constructed using elements in L that involve only words of length at most limit then `SCAlgebraInfoOfFpLieAlgebra` returns a record whose component `sc` contains an algebra that is isomorphic with L / rels . Otherwise `fail` is returned.

The function calls the `fplsa` standalone.

If words is `true` then the component `words` of the result record contains a list of elements in L that correspond to the basis elements.

If rels is `true` then the component `rels` of the result record contains a list of reduced relators in L that describes how algebra generators of L are expressed in terms of the basis elements.

```
gap> RequirePackage( "fplsa" );
true
gap> L:= FreeLieAlgebra( Rationals, "x", "y" );
<Lie algebra over Rationals, with 2 generators>
gap> g:= GeneratorsOfAlgebra( L );; x:= g[1];; y:= g[2];;
gap> rels:= [ x*(x*y) - x*y, y*(y*(x*y)) ];
[ (-1)*(x*y)+(1)*(x*(x*y)), (1)*(((x*y)*y)*y) ]
gap> SCAlgebraInfoOfFpLieAlgebra( L, rels, 100, true, true );
rec( sc := <Lie algebra of dimension 4 over Rationals>,
  words := [ (1)*x, (1)*y, (1)*(y*x), (1)*((y*x)*y) ],
  rels := [ (1)*((y*x)*x)+(1)*(y*x), (1)*(((y*x)*y)*y), (1)*(((y*x)*y)*(y*x))
  ] )
```

2 ► `IsomorphicSCAlgebra(K [,bound])`

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computes a Lie algebra given by a multiplication table isomorphic to the finitely presented Lie algebra K . If the optional parameter *bound* is specified the computation will be carried out using monomials of degree at most *bound*. If *bound* is not specified, then it will initially be set to 10000. If this does not suffice to calculate a multiplication table of the algebra, then the bound will be increased until a multiplication table is found.

If the computation was successful a structure constants algebra will be returned isomorphic to K . Otherwise `fail` will be returned.

```
gap> RequirePackage( "fplsa" );
true
gap> L:= FreeLieAlgebra( Rationals, "x", "y" );
<Lie algebra over Rationals, with 2 generators>
gap> g:= GeneratorsOfAlgebra( L );; x:= g[1];; y:= g[2];;
gap> rels:= [ x*(x*y) - x*y, y*(y*(x*y)) ];
[ (-1)*(x*y)+(1)*(x*(x*y)), (1)*(((x*y)*y)*y) ]
gap> K:= L/rels;
<Lie algebra over Rationals, with 2 generators>
gap> IsomorphicSCAlgebra( K );
<Lie algebra of dimension 4 over Rationals>
```

1.2 Auxiliary Variables of FPLSA

1 ► FPLSA

V

is the global record used by the functions in the package. Besides components that describe parameters for the standalone, the following components are used.

Relation_size

parameter that controls the memory usage by the `fplsa` program,

Lie_monomial_table_size

parameter that controls the memory usage by the `fplsa` program,

Node_Lie_term_size

parameter that controls the memory usage by the `fplsa` program,

Node_scalar_factor_size

parameter that controls the memory usage by the `fplsa` program,

Node_scalar_term_size

parameter that controls the memory usage by the `fplsa` program,

programe

the file name of the executable,

T

structure constants table of the algebra under consideration,

words

list of elements in the free Lie algebra that correspond to the basis elements,

rels

list of relators in the free Lie algebra that are used to express redundant algebra generators in terms of the basis.

In order to be able to run the `fplsa` program successfully, it might be necessary to customize the parameters that control the memory the the program uses, to suit the computer the user is working on. In particular if

the program exits with an error message of the form: `Error, the process did not succeed`, then it may be necessary to change these parameters.

```
gap> RequirePackage( "fplsa" );
true
gap> L:= FreeLieAlgebra( Rationals, "x", "y" );;
gap> g:= GeneratorsOfAlgebra( L );; x:= g[1];; y:= g[2];;
gap> rels:= [ x*(x*y) - x*y, y*(y*(x*y)) ];;
gap> SCAlgebraInfoOfFpLieAlgebra( L, rels, 100, true, true );;
gap> FPLSA;
rec( Relation_size := 2500000, Lie_monomial_table_size := 1000000,
  Node_Lie_term_size := 2000000, Node_scalar_factor_size := 2000,
  Node_scalar_term_size := 20000, progname := "fplsa4",
  T := [ [ [ [ ], [ ] ], [ [ 3 ], [ -1 ] ], [ [ 3 ], [ 1 ] ],
    [ [ 4 ], [ 1 ] ] ],
    [ [ [ 3 ], [ 1 ] ], [ [ ], [ ] ], [ [ 4 ], [ -1 ] ], [ [ ], [ ] ] ],
    [ [ [ 3 ], [ -1 ] ], [ [ 4 ], [ 1 ] ], [ [ ], [ ] ], [ [ ], [ ] ] ],
    [ [ [ 4 ], [ -1 ] ], [ [ ], [ ] ], [ [ ], [ ] ], [ [ ], [ ] ] ],
    -1, 0 ], words := [ 1, 2, [ 2, 1 ], [ [ 2, 1 ], 2 ] ],
  rels := [ [ [ [ 2, 1 ], 1 ], 1, [ 2, 1 ], 1 ],
    [ [ [ [ 2, 1 ], 2 ], 2 ], 1 ], [ [ [ [ 2, 1 ], 2 ], [ 2, 1 ] ], 1 ] ] )
```

1.3 Installing the FPLSA Package

To install unpack the archive file in a directory in the `pkg` hierarchy of your version of GAP 4. (This might be the `pkg` directory of the GAP 4 home directory; it is however also possible to keep an additional `pkg` directory in you private directories, see section 74.1 of the GAP 4 reference manual for details on how to do this.) Go to the newly created `fplsa` directory and call `./configure path` where `path` is the path to the GAP home directory. So for example if you install the package in the main `pkg` directory call

```
./configure ../..
```

This will fetch the architecture type for which GAP has been compiled last and create a `Makefile`. Now simply call

```
make
```

to compile the binary and to install it in the appropriate place.

If you use this installation of GAP on different hardware platforms you will have to compile the binary for each platform separately. This is done by calling `configure` and `make` for the package anew immediately after compiling GAP itself for the respective architecture. If your version of GAP is already compiled (and has last been compiled on the same architecture) you do not need to compile GAP again, it is sufficient to call the `configure` script in the GAP home directory.

Index

This index covers only this manual. A page number in *italics* refers to a whole section which is devoted to the indexed subject. Keywords are sorted with case and spaces ignored, e.g., “PermutationCharacter” comes before “permutation group”.

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