

16.31 INEQ: Support for solving inequalities

This package supports the operator `ineq_solve` that tries to solve single inequalities and sets of coupled inequalities.

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The following types of systems are supported :

- only numeric coefficients (no parametric system),
- a linear system of mixed equations and $\leq - \geq$ inequalities, applying the method of Fourier and Motzkin ¹²,
- a univariate inequality with $\leq, \geq, >$ or $<$ operator and polynomial or rational left-hand and right-hand sides, or a system of such inequalities with only one variable.

For linear optimization problems please use the operator `simplex` of the LINALG package (cf. section 16.37).

Syntax:

```
INEQ_SOLVE (<expr> [, <vl>])
```

where $\langle expr \rangle$ is an inequality or a list of coupled inequalities and equations, and the optional argument $\langle vl \rangle$ is a single variable (kernel) or a list of variables (kernels). If not specified, they are extracted automatically from $\langle expr \rangle$. For multivariate input an explicit variable list specifies the elimination sequence: the last member is the most specific one.

An error message occurs if the input cannot be processed by the currently implemented algorithms.

The result is a list. It is empty if the system has no feasible solution. Otherwise the result presents the admissible ranges as set of equations where each variable is equated to one expression or to an interval. The most specific variable is the first one in the result list and each form contains only preceding variables (resolved form). The interval limits can be formal **max** or **min** expressions. Algebraic numbers are encoded as rounded number approximations.

Examples:

```
ineq_solve ({ (2*x^2+x-1)/(x-1) >= (x+1/2)^2, x>0 });
{x=(0 .. 0.326583), x=(1 .. 2.56777) }
```

¹²described by G.B. Dantzig in *Linear Programming and Extensions*.

```

reg:=
{a + b - c>=0, a - b + c>=0, - a + b + c>=0, 0>=0, 2>=0,
 2*c - 2>=0, a - b + c>=0, a + b - c>=0, - a + b + c - 2>=0,
 2>=0, 0>=0, 2*b - 2>=0, k + 1>=0, - a - b - c + k>=0,
 - a - b - c + k + 2>=0, - 2*b + k>=0,
 - 2*c + k>=0, a + b + c - k>=0,
 2*b + 2*c - k - 2>=0, a + b + c - k>=0}$

ineq_solve (reg,{k,a,b,c});

{c=(1 .. infinity),

b=(1 .. infinity),

a=(max( - b + c,b - c) .. b + c - 2),

k=a + b + c}

```