The MAXIMA TeX interface

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1 How it works

The basic idea is : You can embed Maxima's code using a Latex macro \m as follows:

\m{*expr1; expr2; expr3; ...*}

The macro itself will be replaced by the result of Maxima's computation.

In the present file we will use also another macro, called \M: it works like \m, but in a more commented form.

If the Maxima last expresson *expr* is ended with a ";", the result of the whole computation will be simply discarded.

Example: \m{x+x} will be replaced by *$2x$,* but \m{x+x;} is computed and the result ignored.

In LyX, You can enter the macro as ERT formula, using Ctrl-L or inserting TeX code from the LyX *menu*.

In the current version, the \m macro save its computation context.

You can reset the Maxima cache, putting the command:

```
\m{ kill(all); }
```

at the beginning of your file.

2 Basic examples

Inline sum: $2\,x$

Factorize numbers:

```
\m{factor(30!)}
```

$2^{26}\,3^{14}\,5^{7}\,7^{4}\,11^{2}\,13^{2}\,17\,19\,23\,29$

Algebraic expansion:

```
\m{ expand( (x-2*a)^10 ) }
```

$$x^{10} - 20\,a\,x^9 + 180\,a^2\,x^8 - 960\,a^3\,x^7 + 3360\,a^4\,x^6 - 8064\,a^5\,x^5 + 13440\,a^6\,x^4 - 15360\,a^7\,x^3 + 11520\,a^8\,x^2 - 5120\,a^9\,x + 1024\,a^{10}$$

Big factorial:

```
\m{30!}
```

$$265252859812191058636308480000000$$

3 Trigonometry

Define some function $f(u, v)$:

```
\m{f:  sin(u + v) * cos(u)^3; f}
```

$$\cos^3 u\,\sin\left(v+u\right)$$

Expands in sum of angles

```
\m{ f=trigexpand(f)}
```

$$\cos^3 u\,\sin\left(v+u\right) = \cos^3 u\,\left(\cos u\,\sin v + \sin u\,\cos v\right)$$

Expands in sum of sin and cos:

```
\m{ f=trigreduce(f)}
```

$$\cos^3 u\,\sin\left(v+u\right) = \frac{\sin(v+4\,u)+\sin(v-2\,u)}{8} + \frac{3\,\sin(v+2\,u)+3\,\sin v}{8}$$

4 Calculus

Limits:

```
\m{ f(x):=x/(1-2*x); hold
    limit(f(x),x,inf)
  =limit(f(x),x,inf) }
```

$$\lim_{x\to\infty} \frac{x}{1-2\,x} = -\frac{1}{2}$$

Derivatives:

```
\m{ f(x):=x/(1-2*x); hold
diff(f(x),x,5) =diff(f(x),x,5) }
```

$$\frac{d^5}{d\,x^5}\,\left(\frac{x}{1-2\,x}\right) = \frac{3840\,x}{(1-2\,x)^6} + \frac{1920}{(1-2\,x)^5}$$

Integrals:

```
\m{ f(x):=sin(x)^5; hold
integrate(f(x),x)=integrate(f(x),x)
}
```

$$\int \sin^5 x \, dx = -\frac{\cos^5 x}{5} + \frac{2\cos^3 x}{3} - \cos x$$

Taylor's series up to x^{17}:

```
\m{ f(x):=sin(x);
f(x)=taylor(f(x),x,0,17) }
```

$$\sin x = x - \frac{x^3}{6} + \frac{x^5}{120} - \frac{x^7}{5040} + \frac{x^9}{362880} - \frac{x^{11}}{39916800} + \frac{x^{13}}{6227020800} - \frac{x^{15}}{1307674368000} + \frac{x^{17}}{355687428096000} + \cdots$$

5 System of equations

Solve the system $[x + y = 1, x^2 + y^2 = 1]$:

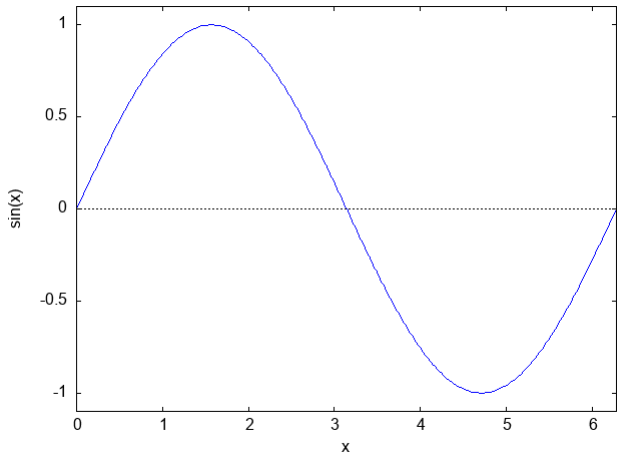
```
\m{ solve([x+y=1,x^2+y^2=1],[x,y])
}
```

$$[[x = 1, y = 0], [x = 0, y = 1]]$$

6 Plotting

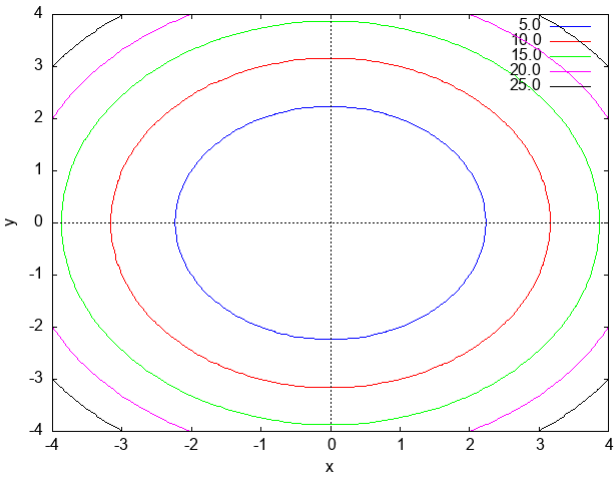
2D plot:

```
\m{ plot2d(sin(x),[x,0,2*\%pi]) }
```



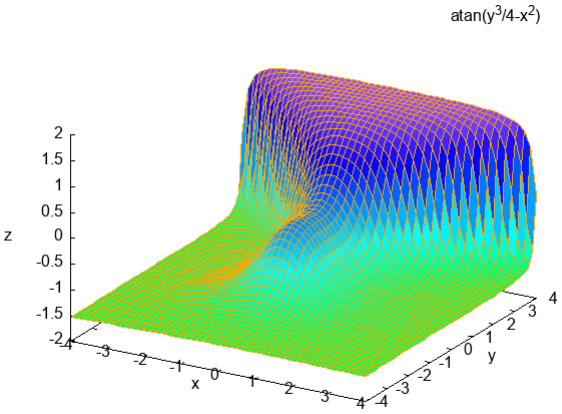
Contour plot:

```
\m{contour_plot (x^2 + y^2, [x, -4,
        4], [y, -4, 4])}
```



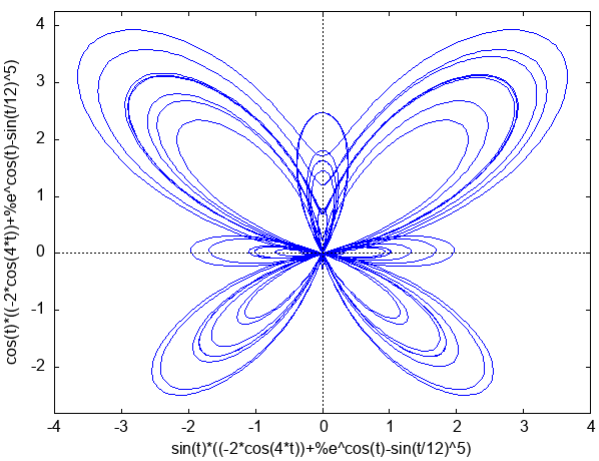
3D plot :

```
\m{plot3d(atan(-x^2+y^3/4),[x,-4,4],[y
```



Parametric plots:

```
                \m{r:
(exp(cos(t))-2*cos(4*t)-sin(t/12)^5);
   plot2d([parametric, r*sin(t),
r*cos(t), [t, -8*\%pi, 8*\%pi]]) }
```



7 Sums and products

Sums:

```
\m{sum(i^2,i,1,n) }
```

$$\sum_{i=1}^{n} i^2$$

Products:

```
\m{ product(i^2,i,1,n) }
```

$$\prod_{i=1}^{n} i^2$$

8 Derivates, integrals

Derivatives:

```
\m{f:sin(x^2); hold
diff(f,x)=diff(f,x) }
```

$$\frac{d}{d\,x}\,\sin x^2 = 2\,x\,\cos x^2$$

Primitives:

```
\m{f:sin(x)*exp(-2*x); hold
integrate(f,x)=integrate(f,x) }
```

$$\int e^{-2\,x}\,\sin x\,dx = \frac{e^{-2\,x}\,(-2\,\sin x - \cos x)}{5}$$

Definite integrals:

```
\m{f:sin(x)*exp(-2*x); hold
integrate(f,x,0,2*\%pi)=integrate(f,x,0,2*\%pi)
}
```

$$\int_0^{2\,\pi} e^{-2\,x}\,\sin x\,dx = \frac{1}{5} - \frac{e^{-4\,\pi}}{5}$$

9 Matrix

Matrix definition:

```
\m{A: matrix([1,2],[3,4])}
```

$$\begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$$

Characteristic polynomial $|A - z \cdot I|$

```
\m{p:charpoly(A,z); p=expand(p)}
```
$$(1-z)\,(4-z)-6=z^2-5\,z-2$$

Determinant $|A|$:

```
\m{ determinant(A)}
```
$$-2$$

Inverse A^{-1}:

```
\m{ invert(A)}
```
$$\begin{pmatrix} -2 & 1 \\ \frac{3}{2} & -\frac{1}{2} \end{pmatrix}$$

Eigenvectors and Eingevalues:

```
\m{ load("eigen"); eigenvectors(A)}
```
$$\left[\left[\left[-\frac{\sqrt{33}-5}{2},\frac{\sqrt{33}+5}{2}\right],[1,1]\right],\left[\left[\left[1,-\frac{\sqrt{33}-3}{4}\right]\right],\left[\left[1,\frac{\sqrt{33}+3}{4}\right]\right]\right]\right]$$

Generate a random matrix B 10×10:

```
\m{ kill(g,A); g:  lambda ([i, j],
          1+random (10));
    B:genmatrix(g,10,10); B }
```
$$\begin{pmatrix} 3 & 3 & 5 & 6 & 5 & 2 & 10 & 6 & 9 & 4 \\ 6 & 6 & 1 & 7 & 10 & 1 & 10 & 5 & 8 & 7 \\ 10 & 10 & 4 & 10 & 7 & 7 & 7 & 4 & 1 & 2 \\ 3 & 10 & 10 & 9 & 7 & 6 & 4 & 4 & 8 & 9 \\ 5 & 7 & 6 & 1 & 8 & 7 & 6 & 5 & 8 & 3 \\ 9 & 4 & 1 & 7 & 3 & 7 & 7 & 8 & 5 & 7 \\ 10 & 2 & 7 & 9 & 3 & 1 & 3 & 3 & 2 & 4 \\ 6 & 3 & 10 & 10 & 2 & 7 & 10 & 1 & 9 & 9 \\ 9 & 4 & 10 & 1 & 7 & 4 & 3 & 4 & 1 & 10 \\ 10 & 5 & 5 & 6 & 8 & 7 & 3 & 2 & 1 & 5 \end{pmatrix}$$

10 Differential Equations

Solve the diff eq:

```
\m{ eq:  hold diff(y,x,2) = -y; eq
              }
```
$$\frac{d^2}{d\,x^2}\,y=-y$$

the general solution is:

```
\m{ gener:  ode2(eq, y, x) }
```
$$y=\%k_1\,\sin x+\%k_2\,\cos x$$

Fixing the initial conditions to $x = 0$, $y = 2$ and $y' = 1$, we find:

```
\m{ sol:  ic2(gener, x=0, y=2, hold          y = sin x + 2 cos x
          diff(y, x)=1) }
```