GNU TEXmacs: a scientic editing platform

by Joris van der Hoeven
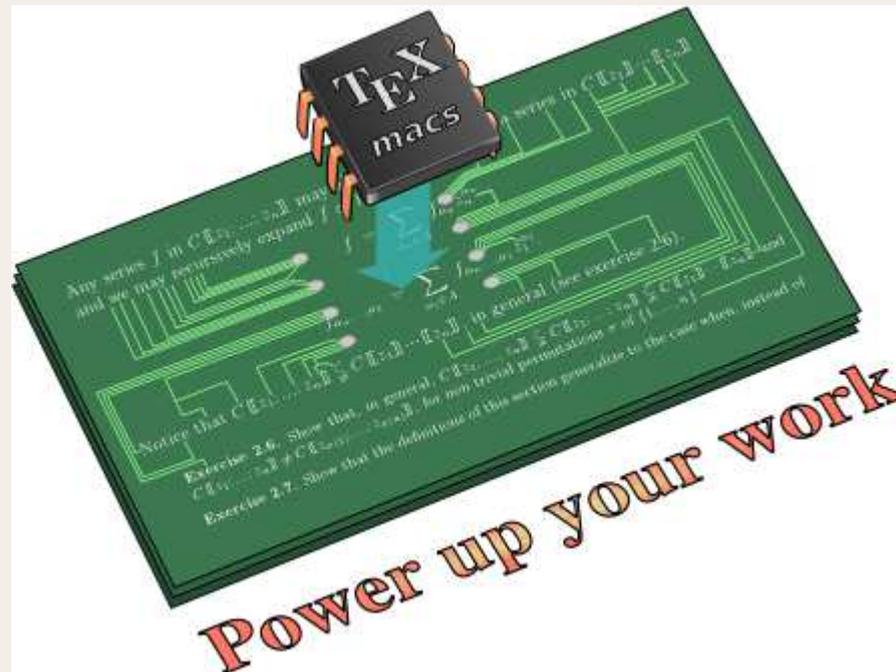
École Polytechnique 2007
`http://www.texmacs.org`

Why T_EX_{MACS}?

A scientific editing platform combines:

- Polyvalent & user-friendly editors for scientific documents & data.
  - Mathematical formulas.
  - Technical pictures.
  - Typed hyperlinks and annotations.
- Possibility to interface the editor with a range of extern software.
  - Interfaces with computer algebra systems.
  - Tools for scientific visualization.
  - Spell checker.
- Common transversal editing tools.
  - Integrated help system.
  - Ergonomy and typesetting quality.
  - Undo, redo, version control.
  - Remote tools like a wiki.

- Presentation mode.

- Import/Export

- Customization and extensability.

  - User provided style files.

  - Scriptability via an extension language.

Example paper (LaTeX export, after compilation, Xhtml/MathML)

Concrete typing

- Style, language.

- Title, section, theorem.

- Mathematics, symbols, common constructs, matrices.

- Graphics.

- Links.

Computer algebra

⇑ A simple Maxima session

```
(C1) diff(x^x^x,x,3);

(C2) expand(integrate(d1,x));

(C4)
```

⇑ Mathematical input

(C4) $\text{integrate}\left(\frac{x^5 + x - 1}{x^2 - 3}, x\right);$

(C7) $\text{expand}\left(\text{diff}\left(-\frac{\log\left(\frac{2\,x - 2\,\sqrt{3}}{2\,x + 2\,\sqrt{3}}\right)}{2\,\sqrt{3}} + 5\log\left(x^2 - 3\right) + \frac{x^4 + 6\,x^2}{4}, x\right)\right);$

(C9)

⇑ Integrated documentation

```
(C9) plot3d([cos(x)*(3+y*cos(x/2)),sin(x)*(3+y*cos(x/2)),y*sin(x/2)],
        [x,-%pi,%pi],[y,-1,1],['grid,50,15])

(C10)
```

⇑ Interoperability – Pari side

pari] $(x + y + z)^{10}$

pari]

⇑ Interoperability – Maxima side

Computer-aided typing

Hallo $1+1$

$$\begin{pmatrix} 1 & 1 & 1 \\ a & b & c \\ a^2 & b^2 & c^2 \end{pmatrix}$$

Graphics

Plot surface
Function
f: $\sin(x + y^2)$
Range
x: $-2\,\pi$ $-$ $2\,\pi$
y: -2 $-$ 2

Mmxlib / Mathemagix
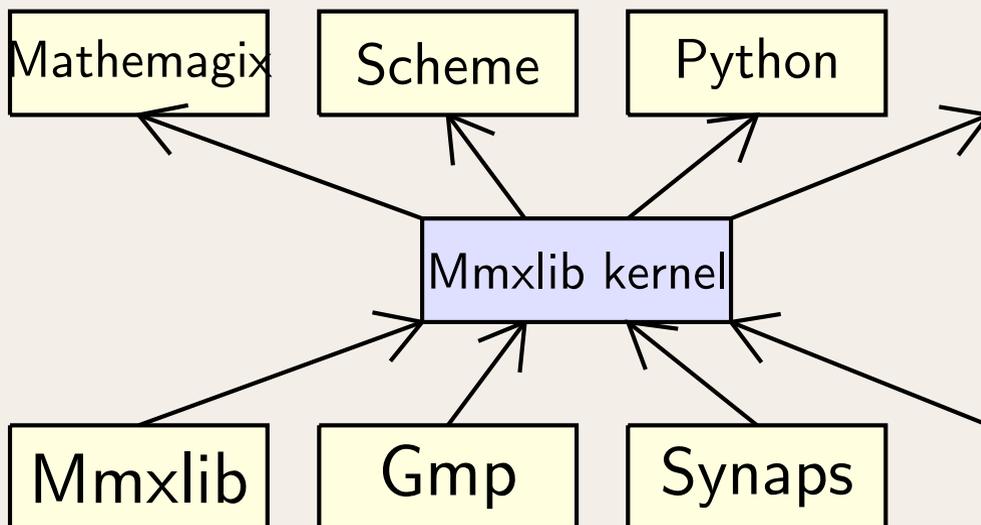
⇑ **Effective real numbers**

`Mmx` ≫ $x: \mathrm{Real} = \sin\sin\mathrm{real}\,2;$

`Mmx` ≫ x

$7.891\,10^{-1}$ Real

`Mmx` ≫ $\mathrm{approximate}(x, 1.0e{-}35);$

$7.8907234357288836143140304248688412\,10^{-1}$ Interval

`Mmx` ≫

Effective real numbers inside other data structures

`Mmx` $\gg$ $M : \text{Matrix Real} = \begin{pmatrix} x & x+2 \\ 2-x^2 & \cos x \end{pmatrix};$

`Mmx` $\gg$ $M;$

$$\begin{bmatrix} 7.891\,10^{-1} & 2.789 \\ 1.377 & 7.045\,10^{-1} \end{bmatrix}$$
Matrix(Real)

`Mmx` $\gg$ $M^{20};$

$$\begin{bmatrix} 2.284\,10^8 & 3.181\,10^8 \\ 1.571\,10^8 & 2.188\,10^8 \end{bmatrix}$$
Matrix(Real)

`Mmx` $\gg$ $\text{approximate}((M^{20})[0,0], 1.0e-50)$

$2.2843459928852193385172328543011328366379595310854326156151\,10^8$ Interval

`Mmx` $\gg$

Effective analytic functions

Mmx $\gg$ z: Analytic $=$ analytic $(0, 1)$;

Mmx $\gg$ $\exp(z)$;

$1.000 + 1.000\,z + 5.000\,10^{-1}\,z^2 + 1.667\,10^{-1}\,z^3 + 4.167\,10^{-2}\,z^4 + 8.333\,10^{-3}\,z^5 + 1.389\,10^{-3}\,z^6 +$
$1.984\,10^{-4}\,z^7 + 2.480\,10^{-5}\,z^8 + 2.756\,10^{-6}\,z^9 + O(z^{10})$ Analytic

Mmx $\gg$ $\exp(z)[\text{int } 20]$;

$4.110\,10^{-19}$ Complex

Mmx $\gg$

⇑ Analytic continuation

Mmx $\gg$ ℓ: Analytic $=$ $\log(1 - z)$;

Mmx $\gg$ $\text{radius}(\ell)$;

$9.99937726184725761359\,10^{-1}$ Floating

Mmx $\gg$ $\text{evaluate}(\ell, \text{complex}(1/2))$;

$-6.931\,10^{-1}$ Complex

Mmx $\gg$ $\text{continuate}(\ell, \text{complex}(1/2))$;

$-6.931\,10^{-1} - 2.000\,z - 2.000\,z^2 - 2.667\,z^3 - 4.000\,z^4 - 6.400\,z^5 - 1.067\,10^1\,z^6 - 1.829\,10^1\,z^7 -$
$3.200\,10^1\,z^8 - 5.689\,10^1\,z^9 + O(z^{10})$ Analytic

Mmx $\gg$ $\text{continuate}(\ell, \text{turn}(\text{complex}(1)))$;

$6.283\,\mathrm{i} - 1.000\,z - 5.000\,10^{-1}\,z^2 - 3.333\,10^{-1}\,z^3 - 2.500\,10^{-1}\,z^4 - 2.000\,10^{-1}\,z^5 - 1.667\,10^{-1}\,z^6 -$
$1.429\,10^{-1}\,z^7 - 1.250\,10^{-1}\,z^8 - 1.111\,10^{-1}\,z^9 + O(z^{10})$ Analytic

Mmx $\gg$

$$f'' = (z^2 + 1)\, f' + e^z\, f; \qquad f(0) = 1,\, f'(0) = 1 + 2\,i.$$

```
Mmx ≫ f: Analytic = solve_lde((z² + 1, exp(z)), (complex(1), complex(1, 2)));
```

```
Mmx ≫ f;
```

$1.000 + (1.000 + 2.000\ i)\ z + (1.000 + 1.000\ i)\ z^2 + (6.667\ 10^{-1} + 1.000\ i)\ z^3 + (5.417\ 10^{-1} + 5.833\ 10^{-1}\ i)\ z^4 + (3.500\ 10^{-1} + 4.833\ 10^{-1}\ i)\ z^5 + (2.278\ 10^{-1} + 2.750\ 10^{-1}\ i)\ z^6 + (1.343\ 10^{-1} + 1.742\ 10^{-1}\ i)\ z^7 + (7.882\ 10^{-2} + 9.767\ 10^{-2}\ i)\ z^8 + (4.361\ 10^{-2} + 5.572\ 10^{-2}\ i)\ z^9 + O(z^{10})$ \qquad Analytic

```
Mmx ≫ u: Complex = evaluate(f, complex(1/10));
```

```
Mmx ≫ u;
```

$1.111 + 2.111\ 10^{-1}\ i$ \hfill Complex

```
Mmx ≫ approximate(u, 1.0e−81);
```

$1.1107245753779445710229272557483056635705254130884819662668704756751790282832834 + 2.1106346012282867466007605052618438398248510727864880851400427655460836641117663\ 10^{-1}\ i$
\hfill Complexify(Interval)

```
Mmx ≫
```

Transversal tools

- Undo / Redo.

- Remote tools.

- Presentation mode.

- Conversions.

- Structured editing (search, variants, navigation, etc.).

$\langle\text{assign}|cd|$

$$A \longrightarrow B$$

$\langle\text{macro}|A|B|C|D|\ \downarrow \qquad \downarrow \ \rangle\rangle$

$$C \longrightarrow D$$

$\langle\text{cd}|A \oplus B|X|Y|C \otimes D\rangle$

$$a + \frac{a+b}{\sqrt{x+y}} + c$$

```scheme
scheme] (select (buffer-tree) '(:* (:match (frac :%1 (sqrt :%1)))))

scheme] (define t
          (car (select (buffer-tree)
                       '(:* (:match (frac :%1 (sqrt :%1)))))))

scheme] (tree-set! t `(frac ,(tree-ref t 1) ,(tree-ref t 0)))

scheme] (tm-define (kbd-return)
          (:inside frac)
          (with-innermost t 'frac
            (tree-set! t `(frac ,(tree-ref t 1) ,(tree-ref t 0)))
            (tree-go-to t 0 :start)))

scheme]
```