

# Lisp

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# Historie Lispu

Vznikl v roce 1958

Massachusetts Institute of Technology (MIT)

Artificial Intelligence Group



Obrázek : John McCarthy

# Tradiční matematická notace

$$\sum_{k=0}^n \binom{n}{k} x^{n-k} y^k$$

$$\int_0^t \varphi(s) \psi(t-s) ds$$

$$(-1)^{-j_1+j_2-m_3} \sqrt{2j_3+1} \begin{pmatrix} j_1 & j_2 & j_3 \\ m_1 & m_2 & -m_3 \end{pmatrix}$$

# Tradiční matematická notace

$$\sum_{k=0}^n \binom{n}{k} x^{n-k} y^k$$

$r^t$

$s) ds$

$(-1)$

$+ \bar{1}$

$\begin{pmatrix} j_1 & j_2 & j_3 \\ m_1 & m_2 & -m_3 \end{pmatrix}$

Nerozumím čínsky.



Tradiční forma

$$\frac{x^4 + 1}{x + 1}$$

# Alternativní matematická notace

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M-expression (funkcionální forma)

```
divide[plus[expt[x, 4], 1], plus[x, 1]]
```

# Alternativní matematická notace

Tradiční forma

$$\frac{x^4 + 1}{x + 1}$$

M-expression (funkcionální forma)

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divide[plus[expt[x, 4], 1], plus[x, 1]]
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S-expression (Lispová forma)

```
(divide (plus (expt x 4) 1) (plus x 1))
```

# Alternativní matematická notace

Tradiční forma

$$\frac{x^4 + 1}{x + 1}$$

M-expression (funkcionální forma)

`divide[plus[expt[x, 4], 1], plus[x, 1]]`

S-expression (Lispová forma)

`(divide (plus (expt x 4) 1) (plus x 1))`

nebo

`(/ (+ (expt x 4) 1) (+ x 1))`



Tradiční forma	M-výraz	S-výraz
$f(x)$	<code>f[x]</code>	<code>(f x)</code>
$a + b$	<code>plus[a, b]</code>	<code>(+ a b)</code>
$a - b$	<code>minus[a, b]</code>	<code>(- a b)</code>
$a - (b + c)$	<code>minus[a, plus[b, c]]</code>	<code>(- a (+ b c))</code>
$a^b$	<code>power[a, b]</code>	<code>(power a b)</code>
$\int_0^\pi \sin x \, dx$	<code>integrate[sin[x], x, 0, pi]</code>	<code>(integrate (sin x) x 0 pi)</code>
$\begin{cases} a, & \text{if } a \geq 0 \\ -a, & \text{if } a < 0. \end{cases}$	<code>if[lower[x, 0], minus[x], x]</code>	<code>(if (&lt; x 0) (- x) x)</code>

# Symbolická derivace

```
#lang racket
(require racket/match)

(define (deriv exp var)
  (match exp
    ((list '+ a b) (list '+ (deriv a var) (deriv b var))) ; (a + b)' = a' + b'
    ((list '* a b) (list '+
                        (list '* a (deriv b var))
                        (list '* (deriv a var) b))) ; ab' = a'b + ab'
    ((? symbol? var1) (if (eq? var1 var) 1 0)) ; x' = 1
    ((? number?) 0))) ; const' = 0
```

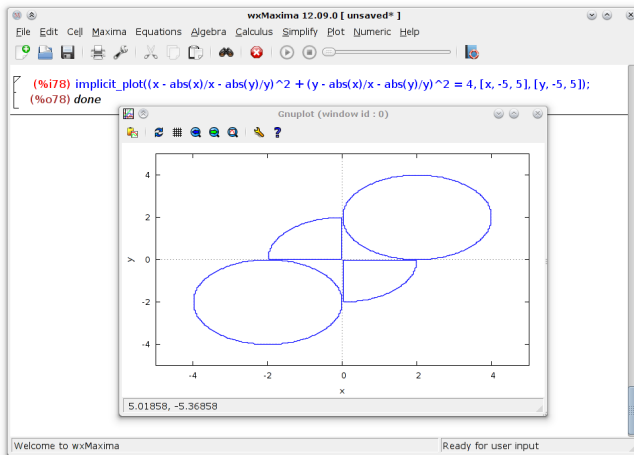
# Symbolické zjednodušení

```
(define (simplify exp)
  (match exp
    ((list '+ a b) (simplify-sum (simplify a) (simplify b)))
    ((list '* a b) (simplify-product (simplify a) (simplify b)))
    (_ exp)))

(define (simplify-sum a b)
  (match (list a b)
    ((list-no-order a 0) a) ; a + 0 = 0 + a = a
    ((list (? number? a) (? number? b)) (+ a b)) ; součet čísel
    ((list a a) (list '* 2 a)) ; a + a = 2a
    (_ (list '+ a b))))

(define (simplify-product a b)
  (match (list a b)
    ((list-no-order a 0) 0) ; a * 0 = 0 * a = 0
    ((list-no-order a 1) a) ; a * 1 = 1 * a = a
    ((list (? number? a) (? number? b)) (* a b)) ; součin čísel
    (_ (list '* a b))))
```

Svobodný počítačový algebraický systém, napsaný v Lispu.



Obrázek : Maxima dělá domácí úkol

Svobodný počítačový algebraický systém, napsaný v Lispu.

MaximaOnAndroid

$$\int_{-\infty}^{\infty} e^{-x^2} dx = \sqrt{\pi}$$

```
(%i23) x^3-6*x^2+11*x-6;
```

$$x^3 - 6x^2 + 11x - 6$$

```
(%i24) solve(%);
```

$$[x = 1, x = 2, x = 3]$$

```
(%i25) diff(x^2+3*x, x);
```

$$2x + 3$$

```
(%i26) (x^4-1)/(x-1);
```

$$\frac{x^4 - 1}{x - 1}$$

```
(%i27) ratsimp(%);
```

$$x^3 + x^2 + x + 1$$

```
ratsimp(%);
```

MaximaOnAndroid

$$\sin\left(\frac{1}{x+1}\right) = e^{x^x}$$

```
(%i4) a+b*x+b*(a/b-x)
```

$$bx + b\left(\frac{a}{b} - x\right) + a$$

```
(%i5) ratsimp(%)
```

$$2a$$

```
(%i6) ((x-1)^(3/2)-(1+x)*sqrt(x-1))/sqrt(x-1)/sqrt(1+x)
```

$$\frac{(x-1)^{\frac{3}{2}} - \sqrt{x-1}(x+1)}{\sqrt{x-1}\sqrt{x+1}}$$

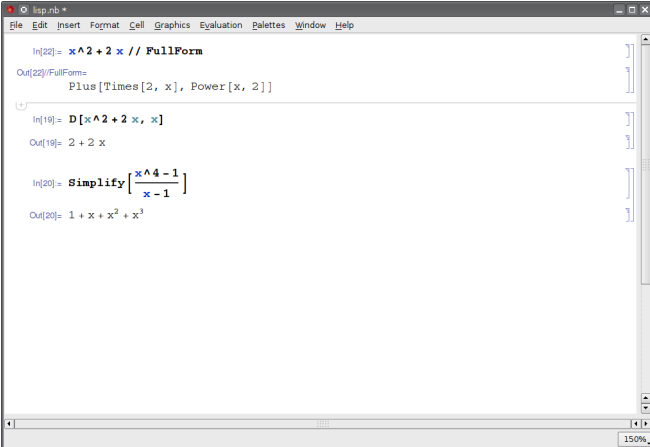
```
(%i7) ratsimp(%)
```

$$-\frac{2}{\sqrt{x+1}}$$

```
example(ratsimp);
```

Obrázek : Maxima na Android

Komerční počítačový algebraický systém.



The screenshot shows the Mathematica 8 interface with a menu bar (File, Edit, Insert, Format, Cell, Graphics, Evaluation, Palettes, Window, Help) and a notebook window titled 'isp.nb'. The notebook contains three input-output pairs:

```
In[22]:= x^2 + 2 x // FullForm
Out[22]/FullForm=
  Plus [Times [2, x], Power [x, 2]]

In[19]:= D [x^2 + 2 x, x]
Out[19]= 2 + 2 x

In[20]:= Simplify [ (x^4 - 1) / (x - 1) ]
Out[20]= 1 + x + x^2 + x^3
```

The interface also shows a status bar at the bottom right indicating a zoom level of 150%.

Obrázek : Mathematica 8

- ▶ Common Lisp
  - ▶ Allegro CL, CLISP, Clozure CL, ECL, LispWorks, SBCL, ...
- ▶ Scheme
  - ▶ Bigloo, Chicken, Guile, Ikarus, Larceny, Racket, Stalin, ...
- ▶ Jiné Lispy
  - ▶ Clojure
  - ▶ Emacs Lisp
  - ▶ Arc, AutoLisp, NewLisp, Picolisp, ...

- ▶ Proč se Lisp moc nepoužívá?

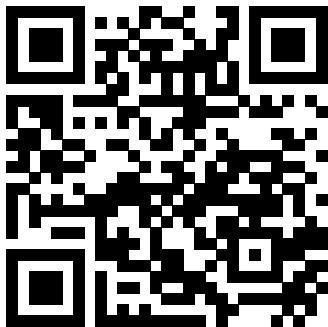


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- ▶ Jaké jsou výhody Lispu?

- ▶ Recursive Functions of Symbolic Expressions and Their Computation by Machine, Part I (John McCarthy)  
<http://www-formal.stanford.edu/jmc/recursive.pdf>
- ▶ History of Lisp (John McCarthy)  
<http://www-formal.stanford.edu/jmc/history/lisp/lisp.html>
- ▶ Lisp I Programmer's Manual  
[http://history.siam.org/sup/Fox\\_1960\\_LISP.pdf](http://history.siam.org/sup/Fox_1960_LISP.pdf)
- ▶ On Lisp (Paul Graham)  
<http://paulgraham.com/onlisp.html>  
<http://paulgraham.com/onlisptext.html>

- ▶ Structure and Interpretation of Computer Programs  
<http://mitpress.mit.edu/sicp/>  
<http://deptinfo.unice.fr/~roy/sicp.pdf>
- ▶ How to Design Programs  
<http://htdp.org/>
- ▶ The Racket Language  
<http://racket-lang.org/>
- ▶ Maxima, a Computer Algebra System  
<http://maxima.sourceforge.net/>  
<https://sites.google.com/site/maximaonandroid/>



<https://bitbucket.org/ujop/lisp/downloads/lisp.pdf>