Polynomy a racionalni funkce

Polynomy a racionalni funkce

```
> restart;
> p1:=-3*x+7*x^2-3*x^3+7*x^4;#collected form
```

$$p1 := -3\,x + 7\,x^2 - 3\,x^3 + 7\,x^4$$

```
> type(p1, 'polynom');
```

true

```
> whattype(p1);
```

$$+$$

```
> ved:=lcoeff(p1);
```

$$ved := 7$$

```
> stupen:=degree(p1);
```

$$stupen := 4$$

Scitani a nasobeni polynomu

```
> p2:=5*x^5+3*x^3+x^2-2*x+1;#expa
```

```
nded canonical form
```

$$p2 := 5\,x^5 + 3\,x^3 + x^2 - 2\,x + 1$$

```
> 2*p1-3*p2+3;
```

$$11\,x^2 - 15\,x^3 + 14\,x^4 - 15\,x^5$$

```
> p1*p2;
```

$$(-3\,x + 7\,x^2 - 3\,x^3 + 7\,x^4)\,(5\,x^5 + 3\,x^3 + x^2 - 2\,x + 1)$$

```
> v1:=expand(%);
```

$$v1 := -17\,x^6 + 11\,x^4 - 20\,x^3 + 13\,x^2 - 3\,x + 56\,x^7 + 4\,x^5 - 15\,x^8 + 35\,x^9$$

Maple neprovadi automaticky roznasobeni, coz vypada jako nevyhoda, ale ve skutecnosti neni.

```
> (3*x+5)^10;
```

$$(3\,x + 5)^{10}$$

```
> expand((3*x+5)^10);
```

$$59049\, x^{10} + 984150\, x^{9} + 7381125\, x^{8} + 32805000\, x^{7} + 95681250\, x^{6} + 191362500\, x^{5} + 265781250\, x^{4} + 253125000\, x^{3} + 158203125\, x^{2} + 58593750\, x + 9765625$$

Cleny polynomu nejsou automaticky usporadany (z pametovych duvodu). Usporadani provedeme pomoci procedury sort (sestupne vzhledem ke stupni polynomu).

```
> sort(v1);
```

$$35\, x^{9} - 15\, x^{8} + 56\, x^{7} - 17\, x^{6} + 4\, x^{5} + 11\, x^{4} - 20\, x^{3} + 13\, x^{2} - 3\, x$$

Sort meni interni datovou strukturu.

```
> restart;
> p:=1+x+x^3+x^2;
```

$$p := 1 + x + x^{3} + x^{2}$$

```
> x^3+x^2+x+1;
```

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

```
> q:=(x-1)*(x^3+x^2+x+1);
```

$$q := (x - 1)(1 + x + x^3 + x^2)$$

```
> sort(p);
```

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

```
> q;
```

$$(x - 1)(x^3 + x^2 + x + 1)$$

```
> ?sort
```

Urcovani koeficientu.

```
> p1:=-3*x+7*x^2-3*x^3+7*x^4;p2:=
  5*x^5+3*x^3+x^2-2*x+1;
```

$$p1 := -3\,x + 7\,x^2 - 3\,x^3 + 7\,x^4$$

$$p2 := 5\,x^5 + 3\,x^3 + x^2 - 2\,x + 1$$

```
> coeff(p2,x^3);
```

$$3$$

```
> coeffs(p2, x, 'pow');pow;
```

$$1, 5, 3, 1, -2$$

$$1, x^5, x^3, x^2, x$$

```
> coeff(x^2-x*(x-1), x);
```

$$1$$

Prikaz **coeffs** pozaduje polynom v roznasobenem tvaru (collected form).

```
> ?coeffs
> p:=x^3-(x-3)*(x^2+x)+1;
```

$$p := x^3 - (x-3)(x^2+x) + 1$$

```
> coeffs(p);
```

```
Error, invalid arguments to coeffs
```

```
> coeffs(expand(p));
```

$$1, 2, 3$$

Jednou ze zakladnich operaci pro polynomy je deleni se zbytkem. Maple ma k tomuto ucelu dve procedury: **quo** a **rem**.

```
> q:=quo(p2,p1,x, 'r');
```

$$q := \frac{5\,x}{7} + \frac{15}{49}$$

```
> r;
```

$$1 - \frac{53}{49}\,x^3 + x^2 - \frac{53}{49}\,x$$

```
> testeq(p2=(q*p1+r));
```

$$true$$

```
> rem(p2,p1,x,'q');
```

$$1 - \frac{53}{49}\,x^3 + x^2 - \frac{53}{49}\,x$$

```
> q;
```

$$\frac{5\,x}{7}+\frac{15}{49}$$

```
> gcd(p1,p2); #nejvetsi spolecny
  delitel polynomu p1 a p2
```

$$x^2+1$$

```
> pol:=expand(p1*p2);
```

$$pol := -17\,x^6+11\,x^4-20\,x^3+13\,x^2-3\,x+56\,x^7+4\,x^5-15\,x^8+35\,x^9$$

```
> expand(sqrt(2+x)*sqrt(3+x));
```

$$\sqrt{2+x}\,\sqrt{3+x}$$

```
> expand(combine(sqrt(2+x)*sqrt(3
  +x), symbolic));
```

$$\sqrt{6+x^2+5\,x}$$

Komplikovanejsi jsou algoritmy pro rozklad polynomu na soucin. Procedura **factor** zapisuje polynom s racionalnimi koeficienty ve tvaru soucinu ireducibilnich polynomu nad Q.

```
> factor(pol);
```

$$x\,(7\,x-3)\,(5\,x^3-2\,x+1)\,(x^2+1)^2$$

Zapis factor(polynom, pole) provadi rozklad nad algebraickym polem.

```
> factor(pol, I);
```

$$x\,(5\,x^3-2\,x+1)\,(7\,x-3)\,(x-I)^2\,(x+I)^2$$

```
> p:=x^2+1;
```

$$p := x^2+1$$

```
> factor(p);
```

$$x^2+1$$

```
> irreduc(p);
```

$$true$$

```
> factor(p,I);
```

$$(x-I)\,(x+I)$$

```
> irreduc(p,I);
```

$$false$$

Silnejsim nastrojem pro rozklady je procedura **split** z knihovny polytools.

```
> pol:=8*x^3-12*x;
```

$$pol := 8\,x^3 - 12\,x$$

```
> factor(pol);
```

$$4\,x\,(2\,x^2 - 3)$$

```
> polytools[split](pol,x);
```

$$8\left(x + \frac{1}{2}\mathrm{RootOf}(\_Z^2 - 6)\right)x \left(x - \frac{1}{2}\mathrm{RootOf}(\_Z^2 - 6)\right)$$

```
> convert(%,'radical');
```

$$8\left(x+\frac{\sqrt{6}}{2}\right)x\left(x-\frac{\sqrt{6}}{2}\right)$$

```
> polytools[split](x^2+1,x);
```

$$(x-\mathrm{RootOf}(\_Z^2+1))\ (x+\mathrm{RootOf}(\_Z^2+1))$$

```
> convert(%,'radical');
```

$$(x-I)\,(x+I)$$

Polynomy vice promennych

```
> pol:=6*x*y^5+12*y^4+14*y^3*x^3
  -15*x^2*y^3 + 9*x^3*y^2 -
  30*x*y^2 - 35*x^4*y + 18*y*x^2
  +21*x^5;
```

$$pol := 6\,x\,y^5+12\,y^4+14\,y^3\,x^3-15\,x^2\,y^3+9\,x^3\,y^2-30\,x\,y^2-35\,x^4\,y+18\,y\,x^2+21\,x^5$$

```
> sort(pol, [x,y], 'plex'); #Pure
  LEXicographic ordering
```

$$21 x^5 - 35 x^4 y + 14 x^3 y^3 + 9 x^3 y^2 - 15 x^2 y^3 + 18 x^2 y + 6 x y^5 - 30 x y^2 + 12 y^4$$

```
> sort(pol, [y,x], 'plex'); #Pure LEXicographic ordering
```

$$6 y^5 x + 12 y^4 + 14 y^3 x^3 - 15 y^3 x^2 + 9 y^2 x^3 - 30 y^2 x - 35 y x^4 + 18 y x^2 + 21 x^5$$

```
> sort(pol, [x,y]); #total degree term ordering
```

$$14 x^3 y^3 + 6 x y^5 + 21 x^5 - 35 x^4 y + 9 x^3 y^2 - 15 x^2 y^3 + 12 y^4 + 18 x^2 y - 30 x y^2$$

Nebo se muzeme na predchazejici polynom divat jako na polynom v promenne x, polynomy v y jsou pak koeficienty.

```
> collect(pol, x);
```

$$21 x^5 - 35 x^4 y + (14 y^3 + 9 y^2) x^3 + (18 y - 15 y^3) x^2 + (-30 y^2 + 6 y^5) x + 12 y^4$$

A obracene:

```
> collect(pol, y);
```

$$6\,x\,y^5+12\,y^4+(-15\,x^2+14\,x^3)\,y^3+(9\,x^3-30\,x)\,y^2+(-35\,x^4+18\,x^2)\,y+21\,x^5$$

Priklady na praci s polynomy vice promennych.

```
> coeff(pol, x^3);
```

$$14\,y^3+9\,y^2$$

```
> coeffs(pol, x, 'powers');
  powers;
```

$$12\,y^4,\ -35\,y,\ 21,\ 14\,y^3+9\,y^2,\ 18\,y-15\,y^3,\ -30\,y^2+6\,y^5$$

$$1,\ x^4,\ x^5,\ x^3,\ x^2,\ x$$

```
> settime:=time():
> factor(pol);
```

$$(3\,x^2-5\,x\,y+2\,y^3)\,(7\,x^3+6\,y+3\,x\,y^2)$$

```
> cpu_time:=time()-settime;
```

$$cpu\_time := 0.016$$

Racionalni funkce

```
> r:=(x^2+3*x+2)/ (x^2+5*x+6);
```

$$r := \frac{x^2 + 3\,x + 2}{6 + x^2 + 5\,x}$$

```
> type(r, 'ratpoly');
```

$$true$$

```
> whattype(r);
```

$$*$$

```
> numer(r), denom(r); #citatel a
  jmenovatel
```

$$x^2 + 3\,x + 2,\ 6 + x^2 + 5\,x$$

Narozdil od racionalnich cisel Maple neprovadi automaticke zjednoduseni.
Zjednoduseni provedeme prikazem **normal** (tak, ze gcd(citatel, jmenovatel)=1).

```
> r;
```

$$\frac{x^2 + 3x + 2}{6 + x^2 + 5x}$$

```
> normal(r);
```

$$\frac{x + 1}{3 + x}$$

Zjednoduseni se provede automaticky pouze v pripade, ze Maple okamzite pozna spolecne cleny.

```
> ff:=(x-1)*numer(r);
```

$$ff := (x - 1)(x^2 + 3x + 2)$$

```
> gg:=(x-1)*denom(r);
```

$$gg := (x - 1)(6 + x^2 + 5x)$$

```
> ff/gg;
```

$$\frac{x^2 + 3x + 2}{6 + x^2 + 5x}$$

```
> expand(ff)/gg;
```

$$\frac{x^3 + 2\,x^2 - x - 2}{(x-1)\,(6 + x^2 + 5\,x)}$$

```
> (x^(100)-1)/(x-1);
```

$$\frac{x^{100} - 1}{x - 1}$$

```
> normal(%);
```

$$1 + x^4 + x^5 + x^3 + x^2 + x + x^6 + x^7 + x^8 + x^9$$
$$+ x^{87} + x^{86} + x^{85} + x^{90} + x^{89} + x^{88} + x^{96} + x^{95}$$
$$+ x^{93} + x^{84} + x^{83} + x^{82} + x^{92} + x^{91} + x^{94} + x^{99}$$
$$+ x^{97} + x^{98} + x^{81} + x^{79} + x^{78} + x^{77} + x^{80} + x^{76}$$
$$+ x^{74} + x^{73} + x^{72} + x^{71} + x^{70} + x^{75} + x^{69} + x^{67}$$
$$+ x^{66} + x^{65} + x^{64} + x^{63} + x^{62} + x^{61} + x^{60} + x^{68}$$
$$+ x^{59} + x^{57} + x^{56} + x^{55} + x^{54} + x^{53} + x^{52} + x^{51}$$
$$+ x^{50} + x^{49} + x^{48} + x^{47} + x^{46} + x^{58} + x^{45} + x^{43}$$

$$+x^{42}+x^{41}+x^{40}+x^{39}+x^{38}+x^{37}+x^{36}+x^{35}$$
$$+x^{34}+x^{33}+x^{32}+x^{31}+x^{30}+x^{29}+x^{28}+x^{27}$$
$$+x^{26}+x^{44}+x^{25}+x^{23}+x^{22}+x^{21}+x^{20}+x^{19}$$
$$+x^{18}+x^{17}+x^{16}+x^{15}+x^{14}+x^{13}+x^{12}+x^{11}$$
$$+x^{10}+x^{24}$$

```
> f:=161*y^3+333*x*y^2+184*y^2+162*x^2*y+144*x*y+77*y+99*x+88:
> g:=49*y^2+28*x^2*y+63*x*y+147*y+36*x^3+32*x^2+117*x+104:
> racfce:=f/g;
```

$$racfce := (161\,y^3+333\,x\,y^2+184\,y^2+162\,x^2\,y+144\,x\,y+77\,y+99\,x+88)\Big/(49\,y^2+28\,x^2\,y+63\,x\,y+147\,y+36\,x^3+32\,x^2+117\,x+104)$$

```
> normal(racfce);
```

$$\frac{18\,x\,y+23\,y^2+11}{4\,x^2+7\,y+13}$$

Rozklad na parcialni zlomky

```
> q:=(x^3+x^2-x+1)/p1;
```

$$q := \frac{x^3 + x^2 - x + 1}{-3\,x + 7\,x^2 - 3\,x^3 + 7\,x^4}$$

```
> convert(q, 'parfrac', x);
```

$$-\frac{1}{3\,x} + \frac{143}{87\,(7\,x - 3)} + \frac{7\,x + 3}{29\,(x^2 + 1)}$$

```
> convert(q,'parfrac',x,real);
```

$$\frac{0.2348111658}{x - 0.4285714286} + \frac{0.1034482759 + 0.2413793105\,x}{x^2 + 1.} - \frac{0.3333333334}{x}$$

```
> convert(%, rational);
```

$$\frac{143}{609\left(x-\frac{3}{7}\right)}+\frac{\frac{7x}{29}+\frac{3}{29}}{x^2+1}-\frac{1}{3x}$$

```
> convert(q,'parfrac',x,I);
```

$$\frac{\frac{7}{58}+\frac{3}{58}I}{x+I}+\frac{\frac{7}{58}-\frac{3}{58}I}{x-I}-\frac{1}{3x}+\frac{143}{87(7x-3)}$$

```
> convert(q, 'fullparfrac', x);
```

$$-\frac{1}{3x}+\frac{143}{609\left(x-\frac{3}{7}\right)}+\left(\sum_{\_\alpha=\mathrm{RootOf}(\_Z^2+1)}\frac{-\frac{3\_\alpha}{58}+\frac{7}{58}}{x-\_\alpha}\right)$$

```
> convert(%, radical);
```

$$-\frac{1}{3x}+\frac{143}{609\left(x-\frac{3}{7}\right)}+\frac{\frac{7}{58}-\frac{3}{58}I}{x-I}+\frac{\frac{7}{58}+\frac{3}{58}I}{x+I}$$

```
> 1/(x^4-5*x^2+6);
```

$$\frac{1}{x^4-5x^2+6}$$

```
> convert(%,parfrac,x);
```

$$\frac{1}{x^2-3}-\frac{1}{x^2-2}$$

```
> convert(%,parfrac,x,sqrt(2));
```

$$\frac{\sqrt{2}}{4(x+\sqrt{2})}+\frac{1}{x^2-3}-\frac{\sqrt{2}}{4(x-\sqrt{2})}$$

```
> convert(%,parfrac,x,{sqrt(2),sq
  rt(3)});
```

$$\frac{\sqrt{2}}{4\,(x+\sqrt{2}\,)} - \frac{\sqrt{3}}{6\,(x+\sqrt{3}\,)} - \frac{\sqrt{2}}{4\,(x-\sqrt{2}\,)} + \frac{\sqrt{3}}{6\,(x-\sqrt{3}\,)}$$

```
> ratfun:=(x-a)/(x^5+b*x^4-c*x^2-
  b*c*x);
```

$$ratfun := \frac{x-a}{x^5+b\,x^4-c\,x^2-b\,c\,x}$$

```
> convert(ratfun, 'parfrac', x);
```

$$\frac{c\,x^2-x^2\,b^2\,a-b\,c\,x-x\,c\,a+b^2\,c+a\,b\,c}{(x^3-c)\,(b^3+c)\,c} + \frac{-b-a}{(x+b)\,b\,(b^3+c)} + \frac{a}{x\,b\,c}$$

Usmerneni:

```
> 2/(2-sqrt(2));
```

$$\frac{2}{2-\sqrt{2}}$$

```
> rationalize(%);
```

$$2+\sqrt{2}$$

```
> z/(1+sqrt(x));
```

$$\frac{z}{1+\sqrt{x}}$$

```
> rationalize(%);
```

$$\frac{z\,(-1+\sqrt{x})}{x-1}$$

Poznamky k manipulaci s polynomy a racionalnimi funkcemi

```
> souc:=(x^2-x)*(x^2+2*x+1);
```

$$souc := (x^2-x)\,(x^2+2\,x+1)$$

```
> expform:=expand(souc);
```

$$expform := x^4 + x^3 - x^2 - x$$

```
> soucin:=(a+b)*(c+d);
```

$$soucin := (b + a)\,(c + d)$$

```
> expand(soucin);
```

$$b\,c + b\,d + c\,a + a\,d$$

Pokud nechceme roznasobovat (c+d), musime to Maplu sdelit uvedenim parametru v procedure expand.

```
> expform:=expand(soucin, c+d);
```

$$expform := (c + d)\,b + (c + d)\,a$$

```
> (x+1)^3;
```

$$(x + 1)^3$$

```
> expand(%);
```

$$x^3 + 3\,x^2 + 3\,x + 1$$

```
> power:=(x+1)^(-2);
```

$$power := \frac{1}{(x+1)^2}$$

```
> expand(power);
```

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

Zaporne mocniny Maple neexpanduje. Musime provest umocneni jmenovatele zvlast.

```
> numer(power)/expand(denom(power
  ));
```

$$\frac{1}{x^2 + 2x + 1}$$

```
> (x+1)^2/((x^2+x)*x);
```

$$\frac{(x+1)^2}{(x^2+x)\,x}$$

Vsimneme si efektu pouziti expand na racionalni lomenou funkci.

```
> expand(%);
```

$$\frac{x}{x^2+x}+\frac{2}{x^2+x}+\frac{1}{(x^2+x)\,x}$$

```
> expand(numer(%%))/expand(denom(
  %%));
```

$$\frac{x^2+2\,x+1}{x^3+x^2}$$

FACTOR

Factor provadi rozklad polynomu na soucin korenovych cinitelu nad racionalnimi cisly.
Zapis factor(polynom, pole) provadi rozklad nad algebraickym polem.

```
> q:=x^2+9/25;
```

$$q := x^2+\frac{9}{25}$$

```
> factor(q,I);
```

$$\frac{(5\,x-3\,I)\,(5\,x+3\,I)}{25}$$

```
> pol:=8*x^3-12*x;
```

$$pol := 8\,x^3-12\,x$$

Silnejsim nastrojem je procedura split (z knihovny polytools):

```
> polytools[split](pol,x);
```

$$8\left(x+\frac{1}{2}\,\mathrm{RootOf}(\_Z^2-6)\right)x\left(x-\frac{1}{2}\,\mathrm{RootOf}(\_Z^2-6)\right)$$

```
> convert(%,'radical');
```

$$8\left(x+\frac{\sqrt{6}}{2}\right)x\left(x-\frac{\sqrt{6}}{2}\right)$$

```
> factor(pol,sqrt(6));
```

$$2\,x\,(2\,x+\sqrt{6}\,)\,(2\,x-\sqrt{6}\,)$$

```
> polytools[split](x^2+1,x);
```

$$(x-\mathrm{RootOf}(\_Z^2+1))\,(x+\mathrm{RootOf}(\_Z^2+1))$$

```
> convert(%,'radical');
```

$$(x-I)\,(x+I)$$

NORMAL

```
> (x-1)*(x+2)/((x+1)*x)+(x-1)/(1+x)^2;
```

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

Vykraceni spolecnych clenu z citatele a jmenovatele, prevod na spolecneho jmenovatele:

```
> normal(%);
```

$$\frac{(x-1)\,(2+4\,x+x^2)}{x\,(x+1)^2}$$

```
> normal(%, expanded);
```

$$\frac{-2\,x+3\,x^2+x^3-2}{x^3+2\,x^2+x}$$

```
> racfce:=(x^4+x^3-4*x^2-4*x)/(x^3+x^2-x-1);
```

$$racfce := \frac{x^4+x^3-4\,x^2-4\,x}{x^3+x^2-x-1}$$

Vsimnete si efektu pouziti prikazu **expand**, **normal**, **factor** v nasledujici posloupnosti prikazu:

```
> factor(racfce);
```

$$\frac{x\,(x-2)\,(2+x)}{(x-1)\,(x+1)}$$

```
> factor(numer(racfce))/sort(expand(denom(racfce)));
```

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

```
> sort(expand(numer(racfce))/factor(denom(racfce));
```

$$\frac{x^4 + x^3 - 4 x^2 - 4 x}{(x-1) (x+1)^2}$$

```
> sort(normal(racfce, 'expanded'));
```

$$\frac{x^3 - 4 x}{x^2 - 1}$$

Nekolik poznamek k praci se systemem

```
> restart;
```

Vice informaci o tom, jak system pracuje, dosahneme nastavenim promenne **printlevel**. Default nastaveni je 1. Zaporna hodnota znamena bez doplnujicich komentaru.

```
> integrate(1/(sin(x)^2+1), x=0..Pi);
```

$$\frac{\pi\sqrt{2}}{2}$$

```
> printlevel;
```

$$1$$

```
> printlevel:=100;
```

$$printlevel := 100$$

```
> integrate(1/(sin(x)^2+1),
  x=0..Pi);
value remembered (at top level): sin(x) -> sin(x)
{--> enter int, args = 1/(sin(x)^2+1), x = 0 .. Pi
value remembered (in int): int/int([1/(sin(x)^2+1), x = 0 .. Pi], 10,
_EnvCauchyPrincipalValue, _EnvAllSolutions, _EnvContinuous) -> 1/2*Pi*2^(1/2)
```

$$answer := \frac{\pi\sqrt{2}}{2}$$

$$\frac{\pi\sqrt{2}}{2}$$

```
<-- exit int (now at top level) = 1/2*Pi*2^(1/2)}
```

$$\frac{\pi\sqrt{2}}{2}$$

```
> printlevel:=1;
```

$$printlevel := 1$$

```
> interface(prettyprint=false):
> solve(a*x^2+b*x+c, x);
```

```
1/2/a*(-b+(b^2-4*a*c)^(1/2)), -1/2*(b+(b^2-4*a*c)^(1/2))/a
```

```
> interface(prettyprint=true):#implicitni nastaveni
> interface(prettyprint=1):
> solve(a*x^2+b*x+c, x);
```

```
           2         1/2          2         1/2
     -b + (b  - 4 a c)       b + (b  - 4 a c)
     ------------------, - ------------------
            2 a                    2 a
```

```
> interface(prettyprint=2):
> solve(a*x^2+b*x+c, x);
```

$$\frac{-b+\sqrt{b^2-4\,a\,c}}{2\,a}, -\frac{b+\sqrt{b^2-4\,a\,c}}{2\,a}$$

```
> sol:=solve(a*x^2+b*x+c, x):
> print(sol);
```

$$\frac{-b+\sqrt{b^2-4\,a\,c}}{2\,a}, -\frac{b+\sqrt{b^2-4\,a\,c}}{2\,a}$$

```
> lprint(sol);
```

```
1/2/a*(-b+(b^2-4*a*c)^(1/2)), -1/2*(b+(b^2-4*a*c)^(1/2))/a
```

```
> interface(verboseproc=2):
> print(unassign);
```

proc(*nom*)

description "remove an assignment from \a

n assigned expression"

...

end proc

Nacteni knihovny

```
> with(student);
```

[D, *Diff, Doubleint, Int, Limit, Lineint,*
Product, Sum, Tripleint, changevar,
completesquare, distance, equate, integrand,
intercept, intparts, leftbox, leftsum, makeproc,
middlebox, middlesum, midpoint, powsubs,
rightbox, rightsum, showtangent, simpson,

***slope, summand, trapezoid*]**

Pokud chceme pouzit pouze jednu konkretni funkci z dane knihovny, muzeme provest jeji volani takto:

```
> student[distance]([1,1],[3,4]);
```

$$\sqrt{13}$$

Seznam knihoven ziskame prikazem

```
> ?index[packages];
```

Napovedu ke konkretni knihovne prikazem

```
> ?student;
```

Definice synonym (pouzivame, kdyz se chceme vyhnout dlouhym jmenum):

```
> restart;
> alias(D = student[distance]);
```

$$D$$

```
> D([1,1],[3,4]);
```

$$\sqrt{13}$$

```
> alias(D=D); #odstrani alias
```

Definice zkratek:

```
> macro(D = student[distance]);
```

$$\mathbf{D}$$

```
> D([1,1],[3,4]);
```

$$\sqrt{\mathbf{13}}$$

```
> macro(D=D);
```

Alias ovlivnuje vstup i vystup, zatimco makro pouze vstup.

```
> alias(c=a^2+b^2);
```

$$c$$

```
> c;
```

$$c$$

```
> 1/(a^2+b^2);c;
```

$$\frac{\mathbf{1}}{c}$$

$$c$$

```
> a^2+b^2;
```

$$c$$

```
> alias(c=c);
> macro(c=a^2+b^2);
```

$$c$$

```
> 1/(a^2+b^2);
```

$$\frac{1}{a^2 + b^2}$$

```
> a^2+b^2;
```

$$a^2 + b^2$$

```
> c;
```

$$a^2 + b^2$$

```
> macro(c=c);
> restart;
```

Ukladani a nacitani dat

Save - uklada ve formatu, ktery se da pozdeji opetne nacist do mapleovskeho zapisniku. Muzeme ukladat v internim formatu Maplu (.m) nebo v textovem formatu:

```
> pol:=x^2+2*x+1; ‘cislo ctyri‘ :=4;
```

$$pol := x^2 + 2\,x + 1$$

$$cislo\ ctyri := 4$$

```
> save pol, ‘cislo ctyri‘, ‘datafile.m‘; #nutne uzavreni do levych apostrofu!
> save pol, ‘cislo ctyri‘, datafile;
> restart;
> pol;
```

$$pol$$

```
> read datafile;
```

$$pol := x^2 + 2\,x + 1$$

$$\textit{cislo ctyri} := 4$$

```
> pol;
```

$$x^2 + 2\,x + 1$$

```
> restart;
> read ‘datafile.m‘;
> pol;
```

$$x^2 + 2\,x + 1$$

V pripade nacteni souboru datafile jsou instrukce opet zobrazeny, v pripade nacteni souboru datafile.m tomu tak neni (nacitani souboru datafile.m je efektivnejsi).

Maple po startu hleda soubor .mapleinit ve Vasem domovskem adresari - zde muzeme zadat prikazy, ktere chceme provadet pri kazdem startu Maplu- napriklad nacteni casto pouzivanych knihoven.

Adresare, ve kterych Maple hleda nacitane knihovny, jsou urcovany promennou libname.

```
> libname;
```

"/usr/local/maple95/lib"

```
> libname:=‘/home_zam/plch/maple‘
  ,libname;
```

libname **:= "/home_zam/plch/maple",**

"/usr/local/maple95/lib"

```
> libname;
```

"/home_zam/plch/maple",

"/usr/local/maple95/lib"

Procedura latex generuje zdrojovy kod LaTeXu pro zadany vzorec (vzorce):

```
> latex((x^2+y^2)/(x^2-y^2));
```

```
{\frac {{x}^{2}+{y}^{2}}{{x}^{2}-{y}^{2}}}
```

```
> (x^2+y^2)/(x^2-y^2);
```

$$\frac{x^2+y^2}{x^2-y^2}$$

```
> latex(%, ‘vzorec1.tex‘);
> polyeq:=x^3-a*x=1;
```

$$polyeq := x^3 - a\,x = 1$$

```
> sols:=solve(polyeq,x);
```

$$sols := \frac{(108 + 12\sqrt{-12\,a^3 + 81}\,)^{(1/3)}}{6}$$

$$+ \frac{2\,a}{(108 + 12\sqrt{-12\,a^3 + 81}\,)^{(1/3)}},$$

$$- \frac{(108 + 12\sqrt{-12\,a^3 + 81}\,)^{(1/3)}}{12}$$

$$- \frac{a}{(108 + 12\sqrt{-12\,a^3 + 81}\,)^{(1/3)}} + \frac{1}{2}\,I\sqrt{3}\,\Bigg($$

$$\frac{(108 + 12\sqrt{-12\,a^3 + 81}\,)^{(1/3)}}{6}$$

$$- \frac{2 a}{(108 + 12 \sqrt{-12 a^3 + 81})^{(1/3)}} \Bigg),$$

$$- \frac{(108 + 12 \sqrt{-12 a^3 + 81})^{(1/3)}}{12}$$

$$- \frac{a}{(108 + 12 \sqrt{-12 a^3 + 81})^{(1/3)}} - \frac{1}{2} I \sqrt{3} \Bigg($$

$$\frac{(108 + 12 \sqrt{-12 a^3 + 81})^{(1/3)}}{6}$$

$$- \frac{2 a}{(108 + 12 \sqrt{-12 a^3 + 81})^{(1/3)}} \Bigg)$$

```
> sol1:=sols[1];
```

$$sol1 := \frac{(108 + 12 \sqrt{-12 a^3 + 81})^{(1/3)}}{6}$$

$$+\frac{2a}{\left(108+12\sqrt{-12a^3+81}\right)^{(1/3)}}$$

```
> CodeGeneration[C](sol1);
```

```
cg0 = pow(0.108e3 + 0.12e2 * sqrt(-0.12e2 * pow(a, 0.3e1) + 0.81e2), 0.1e1 / 0.
3e1) / 0.6e1 + 0.2e1 * a * pow(0.108e3 + 0.12e2 * sqrt(-0.12e2 * pow(a, 0.3e1)
+ 0.81e2), -0.1e1 / 0.3e1);
```

```
> codegen[C](sol1,
  filename=‘vystup.c‘);
> with(CodeGeneration);
```

[*C*, *Fortran*, *IntermediateCode*, *Java*, *LanguageDefinition*, *Matlab*, *Names*, *Save*, *Translate*, *VisualBasic*]

```
> Java(sol1);
```

```
cg2 = Math.pow(0.108e3 + 0.12e2 * Math.sqrt(-0.12e2 * Math.pow(a, 0.3e1) + 0.81
e2), 0.1e1 / 0.3e1) / 0.6e1 + 0.2e1 * a * Math.pow(0.108e3 + 0.12e2 * Math.sqrt
(-0.12e2 * Math.pow(a, 0.3e1) + 0.81e2), -0.1e1 / 0.3e1);
```

```
> Matlab(sol1);
```

```
cg3 = (0.108e3 + 0.12e2 * sqrt((-12 * a ^ 3 + 81))) ^ (0.1e1 / 0.3e1) / 0.6e1 +
0.2e1 * a * (0.108e3 + 0.12e2 * sqrt((-12 * a ^ 3 + 81))) ^ (-0.1e1 / 0.3e1);
```

```
>
```