<u>Ciselne obory v Maplu</u>

Cela cisla

```
> 1;
```

1

```
> whattype(%);
```

integer

```
> ?type,surface
> type(1, integer);
```

true

```
> 4^(4^4);
```

134078079299425970995740249982058461274793658205923933777235\
6144372176403007354697680187429816690342769003185818648605\
0853753882811946569946433649006084096

```
> 123\456\789;
```

123456789

Maple pouziva backslash k tomu, aby ukazal, ze vystup pokracuje na nasledujicim radku.
Pokud je pouzit na vstupu, ignoruje se, slouzi pouze jako vizualni oddelovac.

```
> length(%%);
```

155

Maximalni cele cislo, s kterym je Maple schopen pracovat (na 64-bitovych systemech)
ma

```
> kernelopts(maxdigits);
```

38654705646

platnych cislic.

Figure 2.5. Internal representation of a positive integer.

Datový vektor reprezentuje celé íslo

$$i_0 + i_1 B + i_2 B^2 + i_3 B^3 + \cdots + i_n B^n$$

Maple pouziva nejvetsi mocninu desiti takovou, aby B^2 bylo mozno vyjadrit v jednoduche reprezentaci (B=10^9 na 64-bitovem systemu).

V hlavicce datoveho vektoru Maple pouziva 32 bitu pro specifikaci delky datoveho vektoru, tj. nejvetsi cele cislo muze mit maximalne

```
> 9*((2^32-1)-1);
```

$$38654705646$$

platnych cislic.

Pro cisla mensi nez 2^30 Maple nevyuziva dynamickeho datoveho vektoru.

```
> number:=10^29-10^14-1;
```

$$number := 99999999999999899999999999999$$

Procedury pro praci s celymi cisly:

```
> isprime(%);
```

false

Overuje, zda zadane cislo je prvocislem.

```
> ifactor(number);
```

$$(61)\,(223)\,(13166701)\,(97660768252549)\,(5717)$$

```
> time(ifactor(3!!!));
```

$$0.014$$

```
> ifactor(3!!!);
```

$$(2)^{716}\,(3)^{356}\,(5)^{178}\,(13)^{59}\,(41)^{17}\,(59)^{12}\,(61)^{11}\,(67)^{10}\,(71)^{10}\,(73)^{9}\,(79)^{9}$$
$$(11)^{70}\,(17)^{44}\,(157)^{4}\,(263)^{2}\,(7)^{118}\,(47)^{15}\,(151)^{4}\,(443)\,(29)^{24}\,(31)^{23}$$
$$(37)^{19}\,(43)^{16}\,(53)^{13}\,(23)^{32}\,(701)\,(19)^{38}\,(167)^{4}\,(373)\,(223)^{3}\,(83)^{8}\,(89)^{8}$$
$$(97)^{7}\,(101)^{7}\,(103)^{6}\,(107)^{6}\,(109)^{6}\,(113)^{6}\,(127)^{5}\,(131)^{5}\,(137)^{5}\,(139)^{5}$$
$$(149)^{4}\,(163)^{4}\,(173)^{4}\,(179)^{4}\,(181)^{3}\,(191)^{3}\,(193)^{3}\,(197)^{3}\,(199)^{3}\,(211)^{3}$$
$$(227)^{3}\,(229)^{3}\,(233)^{3}\,(239)^{3}\,(241)^{2}\,(251)^{2}\,(257)^{2}\,(269)^{2}\,(271)^{2}\,(277)^{2}$$
$$(281)^{2}\,(283)^{2}\,(293)^{2}\,(307)^{2}\,(311)^{2}\,(313)^{2}\,(317)^{2}\,(331)^{2}\,(337)^{2}\,(347)^{2}$$
$$(349)^{2}\,(353)^{2}\,(359)^{2}\,(367)\,(379)\,(383)\,(389)\,(397)\,(401)\,(409)\,(419)$$
$$(421)\,(431)\,(433)\,(439)\,(449)\,(457)\,(461)\,(463)\,(467)\,(479)\,(487)$$
$$(491)\,(499)\,(503)\,(509)\,(521)\,(523)\,(541)\,(547)\,(557)\,(563)\,(569)$$
$$(571)\,(577)\,(587)\,(593)\,(599)\,(601)\,(607)\,(613)\,(617)\,(619)\,(631)$$

$(641)\ (643)\ (647)\ (653)\ (659)\ (661)\ (673)\ (677)\ (683)\ (691)\ (709)$
(719)

Rozklad na prvocisla.

```
> nextprime(number);
```

99999999999999900000000000157

Urcuje nejblizsi vetsi prvocislo.

```
> prevprime(number);
```

99999999999999899999999999981

Nejblizsi mensi prvocislo.

```
> ithprime(9);
```

23

Vraci i-te prvocislo.

```
a:=1234: b:=56:
> q:=iquo(a,b);
```

$$q := 22$$

Celociselne deleni.

```
> r:=irem(a,b);
```

$$r := 2$$

Zbytek po celocislenem deleni.

```
> a=q*b+r;
```

$$1234 = 1234$$

```
> testeq(a=q*b+r);
```

true

Kontrola spravnosti.

```
> igcd(a,b);
```

2

Nejvetsi spolecny delitel celych cisel.

```
> lcm(21,35,99);
```

3465

Nejmensi spolecny nasobek cisel 21, 35 a 99.

```
> abs(-3);
```

3

Urceni absolutni hodnoty.

Racionalni cisla.

Maple automaticky odstranuje (krati) nejvetsiho spolecneho delitele citatele a jmenovatele a pozaduje, aby byl jmenovatel kladny.

```
> 4/6;
```

$$\frac{2}{3}$$

```
> whattype(%);
```

fraction

```
> -3/-6;
```

Error, `-` unexpected

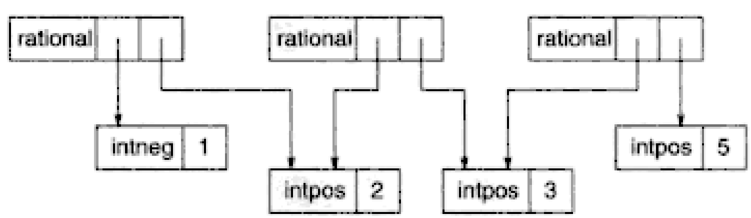

Figure 2.6. Internal representation of the fractions $-\frac{1}{2}$, $\frac{2}{3}$, and $\frac{3}{5}$.

Cisla s pohyblivou desetinou carkou a irracionalni cisla

Maple neprovadi automaticky zjednoduseni. Upravu je nutno vyzadat.

```
> 25^(1/6);
```

$$25^{1/6}$$

```
> simplify(%);
```

$$5^{1/3}$$

```
> evalf(%);
```

1.709975947

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

1.709975947

```
> whattype(%);
```

float

Float(mantissa, exponent)

cislo=mantisa*10^exponent

Zapis cisla 0,000001 ruznymi zpusoby:

```
> 1E-6;
```

0.000001

```
> Float(1,-6);
```

0.000001

```
> printf("%.6f", Float(1,-6));
```

0.000001

```
> evalf(sqrt(2));
```

1.414213562

Presnost aproximace je urcovano promennou Digits.

```
> Digits;
```

10

```
> Digits:=20;
```

$Digits := 20$

```
> evalf(sqrt(2));
```

1.4142135623730950488

```
> evalf[150](Pi);
```

3.14159265358979323846264338327950288419716939937510582097494\
459230781640628620899862803482534211706798214808651328230\
6647093844609550582231725359408 13

```
> evalf(Pi, 150);
```

3.141592653589793238462643383279502884197169399375105820974944\
45923078164062862089986280348253421170679821480865132823066\
64709384460955058223172535940813

```
> interface(displayprecision=6):
> evalf(Pi,150);
```

3.141593

Nemeni presnost vypoctu, pouze zpusob zobrazeni.

```
> interface(displayprecision=-1):
```

Vraci puvodni hodnotu (rusi predchozi omezeni).

```
> ?constants;
> constants;
```

false, γ, ∞, *true*, *Catalan*, *FAIL*, π

```
> Pi:=3.14;
Error, attempting to assign to `Pi` which is protected.  Try declaring `local Pi`; see ?protect for details.
> ?inifcns;
> protect('e');
> macro(e=exp(1)):
> ln(e);
```

1

```
> 3/2*5;
```

$$\frac{15}{2}$$

```
> 3/2*5.0;
```

7.5000000000000000000

Jakmile zadame nejake cislo v pohyblive desetinne carce, Maple pri vypoctu automaticky pouzije aproximativni aritmetiku.

```
> ceil(7.5);
```

8

```
> floor(7.5);
```

7

ceil(x) urci nejmensi cele cislo vetsi nebo rovne x, floor(x) nejvetsi cele cislo mensi nebo rovne x (pro realna x).

```
> round(7.4);round(7.6);round(7.5);
```

$$7$$
$$8$$
$$8$$

```
> trunc(7.4);trunc(-7.4);
```

$$7$$
$$-7$$

```
> frac(7.5);
```

$$0.5$$

frac(x) vraci desetinnou cast cisla x, tj. frac(x)=x-trunc(x).

Pocitani s odmocninami.

```
> (1/2+1/2*sqrt(5))^2;
```

$$\left(\frac{1}{2}+\frac{1}{2}\sqrt{5}\right)^2$$

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

$$\frac{3}{2}+\frac{1}{2}\sqrt{5}$$

```
> 1/%;
```

$$\frac{1}{\frac{3}{2}+\frac{1}{2}\sqrt{5}}$$

```
> simplify(%);
```

$$\frac{2}{3+\sqrt{5}}$$

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

$$\frac{3}{2}-\frac{1}{2}\sqrt{5}$$

```
> 1/(1+sqrt(2));
```

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

```
> simplify(%);
```

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

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

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

```
> (4+2*3^(1/2))^(1/2);
```

$$\sqrt{4+2\sqrt{3}}$$

```
> simplify(%);
```

$$\sqrt{3}+1$$

```
> sqrt(25+5*sqrt(5))-sqrt(5+sqrt(5))-2*sqrt(5-sqrt(5));
```

$$\sqrt{25+5\sqrt{5}}-\sqrt{5+\sqrt{5}}-2\sqrt{5-\sqrt{5}}$$

```
> simplify(%);
```

$$0$$

```
> (-8)^(1/3);
```

$$(-8)^{1/3}$$

```
> simplify(%);
```

$$1+I\sqrt{3}$$

```
> with(RealDomain);
```

[$\Im$, $\Re$, \`^\`, arccos, arccosh, arccot, arccoth, arccsc, arccsch, arcsec, arcsech, arcsin, arcsinh, arctan, arctanh, cos, cosh, cot, coth, csc, csch, *eval*, exp, *expand*, *limit*, ln, log, sec, sech, signum, *simplify*, sin, sinh, *solve*, sqrt, surd, tan, tanh]

```
> (-8)^(1/3);
```

$$-2$$

```
> restart;
> (-1-3*Pi-3*Pi^2-Pi^3)^(1/3);
```

$$(-\pi^3-3\pi^2-3\pi-1)^{1/3}$$

```
> simplify(%);
```

$$\frac{1}{2}(\pi+1)(I\sqrt{3}+1)$$

```
> use RealDomain in simplify((-1-3*Pi-3*Pi^2-Pi^3)^(1/3)) end use;
```

$$-\pi - 1$$

Algebraicka cisla:
Koreny iredicibilnich polynomu nad racionalnimi cisly.

Vnitrni reprezentace algebraickych cisel pomoci procedury RootOf, napr. sqrt (2)
je reprezentovana nasledujicim zpusobem:

```
> alpha:=RootOf(z^2-2,z);
```

$$\alpha := RootOf(\_Z^2 - 2)$$

Prevod na tvar "odmocniny" provadime pomoci procedury convert.

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

$$\sqrt{2}$$

Protoze alpha muze byt bud sqrt(2) nebo -sqrt(2), vsechny hodnoty ziskame pomoci prikazu allvalues:

```
> allvalues(alpha);
```

$$\sqrt{2}, -\sqrt{2}$$

Zpetny prevod:

```
> convert(sqrt(2), 'RootOf');
```

$$RootOf(\_Z^2 - 2, index = 1)$$

```
> simplify(alpha^2);
```

$$2$$

```
> simplify(1/(1+alpha));
```

$$RootOf(\_Z^2 - 2) - 1$$

```
> convert((-8)^(1/3), 'RootOf');
```

$$1 + RootOf(\_Z^2 + 3, index = 1)$$

```
> convert(sqrt(3), 'RootOf');
```

$$RootOf(\_Z^2 - 3, index = 1)$$

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

$$\sqrt{3}$$

```
> root[3](2);
```

$$2^{1/3}$$

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

$$RootOf(\_Z^3 - 2, index = 1)$$

Nekonecno

```
> infinity;
```

$$\infty$$

```
> infinity-123;
```

$$\infty$$

```
> infinity*5;
```

$$\infty$$

Komplexni cisla.

```
> restart;
> Complex(0,1); Complex(2,3);
```

I

$$2 + 3\,I$$

```
> (2+3*I)*(4+5*I);
```

$$-7 + 22\,I$$

```
> whattype(%);
```

$$complex(extended\_numeric)$$

```
> Re(%%), Im(%%), conjugate(%%), abs(%%);
```

$$-7, 22, -7 - 22\,I, \sqrt{533}$$

```
> 1/%%%;
```

$$-\frac{7}{533} - \frac{22}{533}\,I$$

```
> sqrt(-8);
```

$$2\,I\sqrt{2}$$

```
> restart;
```

```
> 1/(2+a-b*I);
```

$$\frac{1}{2+a-\mathrm{I}\,b}$$

```
> evalc(%);
```

$$\frac{a+2}{(a+2)^2+b^2}+\frac{\mathrm{I}\,b}{(a+2)^2+b^2}$$

Provadi zjednoduseni v oboru komplexnich cisel.

```
> abs(%%);
```

$$\frac{1}{|2+a-\mathrm{I}\,b|}$$

```
> evalc(%);
```

$$\frac{1}{\sqrt{(a+2)^2+b^2}}$$

```
> #interface(imaginaryunit=J);
> #Complex(2,3);
> restart;
```