## my Maple cheat sheet

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some rules of thumbs when using Maple

How to write derivative

How to solve heat PDE in 1D in Maple

How to make multiple assumptions on a symbol?

How to make Maple display \( \frac{dy}{dx} \) as \( y'(x) \)?

How to check if expression is an equation?

How to check if expression is a set?

How to set boundary conditions for dsolve or pdsolve?

How to export a plot to PDF?

How to find all roots of complex number

How to find a particular solution to ODE?

```maple
restart;
ode := diff(y(x), x) + y(x)^2*sin(x) - 2*sin(x)/cos(x)^2 = 0;
yp := DETools:-particularsol(ode);
```

2 How to convert Mathematica expression to Maple?

```maple
restart;
with(MmaTranslator); #load the package
FromMma(`Integrate[Cos[x],x]`);
Or
restart;
with(MmaTranslator); #load the package
custom(`Integrate[Cos[x],x]`, FromMma);
```

3 How to debug internal procedures, such as dsolve?

```maple
f := proc()
  eq := x*diff(y(x), x) + y(x) = exp(2*x);
dsolve(eq, y(x));
end proc;
Then used the command stopat(f); then called the procedure f(); and now the debugger comes
```
4 How to display or print source code of a function or procedure in MAPLE?

For integration use

```
infolevel[`evalf/int`]:=5; infolevel[int]:=5;
```

Another option

```
restart;
interface( verboseproc=3 ) #(try 2 also)
```

then print(procedure); or eval(procedure_name); for example

```
restart:
interface( verboseproc=3):
print(LinearAlgebra:-GramSchmidt);
print(lcm);
```

Also can use showstat, in this case interface( verboseproc=3 ) is not needed. Also showstat gives line numbers and I think it is easier to read.

```
showstat(`odsolve/2nd_order`)
showstat(`evalf/hypergeom`);
showstat(`evalf/exp/general`);
showstat(`evalf/Psi`);
showstat(`evalf/int`);
showstat(`dsolve/SERIES`);
```

There is also a function by Joe Riel [here] here is the post by Joe Riel:

"A disadvantage of showstat, particularly if you want to cut and paste the output, is that it includes line numbers. Here is a simple procedure I threw together to remove the line numbers."

PrintProc := proc(p::name,lines::{posint,posint..posint})
local width;
option `Copyright (C) 2004 by Joseph S. Riel. All rights reserved.`;
description "Print like showstat, but without line numbers";
width := interface('screenwidth'=200);
try
printf("%s",
StringTools:-RegSubs(
"\n ...." = "\n",
debugopts('procdump'= `if`(nargs=1,p,[args]))))
catch "procedure name expected":
error "%1 is not a procedure name",p
finally interface('screenwidth'=width)
end try;
NULL
end:

To print source code to file using the above, do the following

```
currentdir("C:\\data");
interface('prettyprint'=1):
interface('verboseproc'=3):
writeto("listing.txt")
PrintProc('singular');
writeto('terminal');
```

Now the output will show up in the file "listing.txt" and also no line wrapping. The above I found is the best solution so far to do this.

5 How to display trace of a function as it runs in maple?

```
trace(foo);
untrace(foo);
```
also see debug(foo);

Also

```
infolevel[all]:=5:
printlevel:=10:
```


Also look at kernelopts(opaquemodules=true)

Here is a useful post by [CarlLove](http://www.mapleprimes.com) from Maple prime forum that summarizes all of these
Here are four things that you can do to get more information. I have listed them in order by how structured the information is, with the most structured first.

1. Set

```plaintext
infollevel[all]:= 5;
```

That will cause programs to print out additional information of the programmers’ choosing. You can use higher or lower numbers for more or less information. Most programs don’t use levels higher than 5.

2. Print the code of procedures with showstat:

```plaintext
showstat(int);
showstat(sin);
showstat(cos);
```

3. Trace the execution of particular procedures with trace:

```plaintext
trace(int);
trace(sin);
```

4. Trace the execution of everything with printlevel:

```plaintext
printlevel:= 10000:
```

You can use higher or lower numbers for more or less information.

6 How to display a built-in function code?

```plaintext
interface(verboseproc=3);
print(DEtools)
```

Or to see line numbers

```plaintext
interface(verboseproc=3);
showstat(dsolve)
```

Or can use the `Browse()` command

```plaintext
with(LibraryTools);
Browse();
```

Another option I found is

```plaintext
s:=debugopts(procdump=`showstat`);
```

Then the above produces listing that can be copied as string with line wrapping ok.
7 How to build a LIST or a SET on the fly?

One way

```plaintext
L:=[ ]:
for i from 1 to 3 do :
   L:=[op(L),i];
end do;
```

But a better way is to use seq

```plaintext
L:=[seq(i,i=1..3)];
    L := [1, 2, 3]
```

8 How to make function display more information of what it is doing?

By Carol Devore on the net:

Use infolevel.
For example, to show what logic dsolve uses, do this:

First try
> infolevel[all]:= 5;

That will probably give more information than you want, but if not, then try
> printlevel:= 1000;

If you want information about a specific procedure, you can use debug.
For example,
restart;
debug(`int/int`);
int(p, x= 0..1);

To find out what procedures are being called without getting too much extra information, use excallgraph.

Trying on dsolve
infolevel[dsolve]:= 3;
dsolve({eq1},y(x));

Methods for second order ODEs:
Trying to isolate the derivative d^2y/dx^2...
Successful isolation of d^2y/dx^2
--- Trying classification methods ---
trying a quadrature
trying high order exact linear fully integrable
trying differential order: 2; linear nonhomogeneous with symmetry [0,1]
trying a double symmetry of the form [xi=0, eta=F(x)]
<- double symmetry of the form [xi=0, eta=F(x)] successful

9 How to solve a differential equation with initial conditions?

To solve

\[ y'' - 3y' + 2y = 10e^{5x} \]

with \( y(0) = 1 \), \( y'(0) = 5 \) do

\[
\begin{align*}
eq1 & := \text{diff}(y(x),x$2)-3*\text{diff}(y(x),x)+2*y(x) = 10*\exp(5*x); \\
dsolve({eq1,y(0)=1,D(y)(0)=5},y(x));
\end{align*}
\]

Methods for second order ODEs:
Trying to isolate the derivative d^2y/dx^2...
Successful isolation of d^2y/dx^2
--- Trying classification methods ---
trying a quadrature
trying high order exact linear fully integrable
trying differential order: 2; linear nonhomogeneous with symmetry [0,1]
trying a double symmetry of the form [xi=0, eta=F(x)]
<- double symmetry of the form [xi=0, eta=F(x)] successful
......

The above can also be written using D@@ notation, like this

\[
\begin{align*}
eq & := (D@@2)(y)(x) - 3*D(y)(x) +2*y(x) = 10*\exp(5*x); \\
IC & := y(0)=1,D(y)(0)=5; \\
dsolve({eq,IC},y(x));
\end{align*}
\]

10 How to verify that the ODE solution given is correct?

use odetest and check if it gives zero.
eq1:= diff(diff(y(x),x),x)-3*diff(y(x),x)+2*y(x)=10*exp(5*x);
ans:=dsolve({eq1,IC},y(x));
odetest(ans,eq1);

0

11 How to know the type of ODE?

Maple can classify the ODE.

R0 := DEtools[‘odeadvisor’](eq1,y(x));

R0 := [[_2nd_order, _with_linear_symmetries]]

To get help on this type of ODE, do

DEtools['odeadvisor'](eq1,'help');

12 What packages to load for differential equations?

Use with(DEtools);

13 How to plot solution of differential equations?

restart;
DEtools[DEplot](eq1,y(x),x=-2..5, [ [y(0)=0, D(y)(0)=0]], y=-3..3,linecolor=red);

To get a better plot, change the stepsize and independent variable range
14 How to plot a function?

Here, I am looking at fouries series expansion of \( f(x) = 0 \) between \( \pi \) and 0, and \( f(x) = 1 \) between 0 and \( \pi \).

The Fouries series expansion is worked out to be as below. This shows that the series approximate the above \( f(x) \) as more terms are added

```
restart;
f:=(x)-> 1/2 + (1/Pi)*(sin(x)+sin(3*x)/3+sin(5*x)/5+sin(7*x)/7);
plot(f(x),x=-10..10);
```

15 How to run maple from command line?

From DOS, point to where your cmaple is

```
>"C:\Program Files\Maple 7\BIN.WNT\"cmaple
```

To make it execute maple commands use the < foo.txt to pipe maple commands in the file to it.
16  How to use matrices in maple?

A:= Matrix( [ [1, 2, 3] ,
            [3, 6, 7] ,
            [5, 6, 9] ,
            [7, 7, 7] ]
            )
            
            whattype(A);
            Matrix
            
            size:=LinearAlgebra:-Dimension(A);
            size := 4, 3
            
            row:=size[1];
            row := 4
            
            col:=size[2];
            col := 3
            
            You can extract any part of the matrix like this:
            
            B:=A[1..3,2..2];
            
            \[
            \begin{pmatrix}
            2 \\
            6 \\
            6 
            \end{pmatrix}
            \]

            By Carl Devore http://mathforum.org/kb/message.jspa?messageID=1570678
Maple list and sequence structures are more flexible than Matrices, which are highly structured. A Maple list of lists (called a listlist in Maplese) is akin to a matrix in some other languages. Many matrix operations can be performed directly on the listlist form, but to do serious linear algebra, you should convert to a Matrix. Of course, it is trivial to convert a listlist to Matrix:

\[
\text{LL:= } \begin{bmatrix} 1,2, & 3,4 \end{bmatrix} \\
\text{M:= Matrix(LL);} \\
\]

So here is another solution in line with your original wishes. This is "index free", but the table-based solution I gave earlier should be faster. (It is usually considered bad form to repeatedly append to a list or sequence.)

\[
\text{L:= } [][]; \quad \text{# Create a NULL sequence} \\
\text{do} \\
\quad \text{line:= readline(file);} \\
\quad \text{if line::string then} \\
\quad \quad \text{if line contains valid data then} \\
\quad \quad \quad \text{Z:= a list of that data;} \\
\quad \quad \quad \text{L:= L, Z} \\
\quad \quad \text{fi} \\
\quad \text{else} \\
\quad \quad \text{break} \\
\quad \text{fi} \\
\text{od} \\
\text{A:= Matrix([L]); \quad \text{# Note []: seq -> list.}}
\]

To move move a column into a matrix: Here, I want to copy 2nd column to the 3rd column:

\[
\text{A;} \\
\begin{bmatrix}
1 & 2 & 3 \\
3 & 6 & 7 \\
5 & 6 & 9 \\
7 & 7 & 7
\end{bmatrix}
\]

\[
\text{B:=A[1..row,2];} \\
\begin{bmatrix}
2 \\
6 \\
6 \\
7
\end{bmatrix}
\]

\[
\text{A[1..row,3]:=B;} \\
\text{A;}
\]
17 How can maple return more than value from a procedure call?

Maple can return multiple values. Make sure to use the comma "," in the body of the procedure to separate each return value. Example:

```maple
size_matrix := proc(x) 3*x, 4*x; end proc;
row, col := size_matrix(5);
```

18 How does maple handle procedure arguments?

When passing a variable to maple procedure, the variable VALUE is passed to the procedure (This is different from say Fortran where the default is pass by reference). But this is the same as with Mathematica.

For example, if a variable X had value 10, then you call a procedure FOO passing it X, then inside FOO, X will be the number 10, not the argument variable X. So, this means one can not have X on the left hand side inside FOO. Like this

```maple
x := 1
```

The only way to assign new value to the input and return new value, is to use a local variable, like this:

```maple
one := proc(x)
  local y;
  print(x);
  y := x + 1;
  print(x);
  y;
end proc;
```

```maple
z := 'z';
z := 5;
f := one(z);
```

```maple
f := 6
```

19 How to define your own data types?

Use `type/name` to define new type name.
20 How to find max element in a matrix and its position as same time?

Code from net by Carl Devore:

```plaintext
MMax:= proc(M::{Matrix,matrix})
  local C,r,c,mx,L,p;
  C:= op('if'(M::Matrix, [1,2], [2,2,2]), eval(M));
  L:= map(op, convert(M, listlist));
  mx:= max(L[]);
  member(mx,L,'p');
  r:= iquo(p, C, 'c');
  mx, `if`(c=0, [r,C], [r+1,c])
end;
```

Code below from C W

```plaintext
A:=matrix(12,12,rand(100));
Ao:=array((proc(E)
  local i; [seq(i=(rhs=lhs)(E[i]),i=1..nops(E))end)
  (sort(op(3,eval(A)),proc(E1,E2) if rhs(E1)>rhs(E2)
    then
    true
  else
    false
  fi
  end))));
Ao[1];
```

21 How to create a package?

First create the module:
restart;

nma:= module()
option package;
export getMaxMatrix;
getMaxMatrix := proc (M::{matrix, Matrix})
local C, r, c, mx, L, p;
C := op(`if`(M::Matrix,[1, 2],[2,2,2]),eval(M));
L := map(op,convert(M,listlist));
mx := max(L[]); member(mx,L,'p');
r := iquo(p,C,'c');
mx, `if`(c = 0,[r, C],[r+1, c])
end proc;
end module;

A:= Matrix( 
[ [1, 2, 3] ,
[3, 6, 7] ,
[5, 6, 9] ,
[7, 7, 7] ]

nma[getMaxMatrix](A); |

Gives 9, [3, 3]. Now save the module.

savelibname := "C:/MAPLE_PACKAES";
march('create', savelibname, 20);

now save the library to disk. savelib(nma);

Now we can test everything by reinitialize everything and reload the library.

>restart
#Add my library to LIBNAME
>libname:="C:/MAPLE_PACKAGES",libname;
>A:=matrix( [ [1,2,3],[4,6,9] ]);
>with(nma);
>nma[getMaxMatrix](A);

Now to print a proc() in the package, do

>interface(verboseproc=3);
> print(nma[getMaxMatrix]);

Now you can list what packages exist in the archive:

march('list',savelibname);
march('extract',savelibname,":-1.m","C:MAPLE_PACKAGES/t.m")
Some notes. need to clean later

> module1lib:=`module1\lib`;
> system("md "||module1lib);
> march('create',module1lib,100);
> makehelp(module1,`module1/module1.mws`,module1lib):
> makehelp(`module1/export1`, `module1/export1.mws`,module1lib):
> savelibname:=module1lib: ### doesn't affect current libname
> savelib(module1); ### no error message
> restart;
> module1lib:="module1\lib":
> libname:=module1lib,libname; ### now Maple will find module1
> with(module1);
> ?module1

Also there is a long thread here on Maple prime on making personal packages in Maple

22 How to convert from floating point to Hex?

From: Robert Israel (israel@math.ubc.ca)
Subject: Re: Getting non-integral results in hex
Newsgroups: comp.soft-sys.math.maple
Date: 2003-06-13 00:07:37 PST

I assume you mean floating-point numbers. Note that Maple floats (as opposed to "hardware floats") are in fact stored in base 10. To convert a float to hex with n digits after the ",", you can use this:

> `convert/hexfloat`: := proc(x::numeric, n::nonnegint)
local A,B,ax,R;
if nargs = 1 then return procname(x,round(Digits*log[16](10))) fi;
if x = 0 then return cat(`0.`,'0'$$n) fi;
ax:= abs(x);
A:= floor(ax);
B:= round(frac(ax)$$16$$n);
if B = 16$$n then A:= A+1; B:= 0 fi;
R:= cat(convert(A,hex),`.`);
if x < 0 then R:= cat(`-`,R) fi;
cat(R,substring(convert(16$$n+B,hex),2..-1));
end;

And then, e.g.:

> convert(1234.5678, hexfloat, 4);

4D2.915B
23 How to find taylor series expansion of functions?

mtaylor(sin(x),[x],10);

\[ x - \frac{1}{6}x^3 + \frac{x^5}{120} - \frac{x^7}{5040} + \frac{x^9}{362880} \]

24 How to print elements of a matrix?

```maple
restart;
a:=Matrix([[2,3,4],[4,5,6]]);
nRow,nCol :=LinearAlgebra[Dimension](a);
for i from 1 to nRow do
    for j from 1 to nCol do
        printf("a(%d,%d)=%d\n",i,j,a[i,j]);
    end do;
end do;
a(1,1)=2
a(1,2)=3
a(1,3)=4
a(2,1)=4
a(2,2)=5
a(2,3)=6
```

25 How to find determinant of matrix?

```maple
restart;
a:=Matrix([[2,4],[5,7]]);
LinearAlgebra:-Determinant(a);
-6
```

26 How to generate Hilber matrix?

```maple
H := LinearAlgebra:-HilbertMatrix(5);
```
27 How to plot matrix data?

Matlab is much easier here. In maple, need to covert the matrix to a list of list of points first.

```
restart;
H := LinearAlgebra:-HilbertMatrix(5):
nRow, nCol := LinearAlgebra[Dimension](H):
L := [seq([seq([i, j, H[i, j]], i = 1 .. nRow), j = 1 .. nCol])]:
plots:-surfdata(L);
```

28 How to catch an error from a proc()?

An error in maple raises an exception. So, use try catch to trap it as follows:

```
try
    v, pos := MMMax(4);
catch:
    printf("an error is caught\n");
end try;
```
29 How to convert 3456 to 3,456?

From the net, by Carl Devor:

```maple
`print/commas`:proc(N::integer)
local n,s,i,b;
n:= ListTools:-Reverse(convert(abs(N), base, 1000));
if N<0 then n:= subsop(1= -n[1], n) fi;
nprintf("%s", sprintf(cat("%d", ",%03d" $ nops(n)-1), n[]))
end proc:

commas(456554);

456,554
```

To convert a string to array of chars use `array(StringTools:-Explode(S))`

```maple
s:="Nasser M. Abbasi":
r:=array(StringTools:-Explode(s));
r:=["N" "a" "s" .......]
```

Now can use the string as normal array

```maple
r[4];
"s"
```

30 How to use units?

```maple
Units[GetDimensions](base):
amount_of_information, amount_of_substance, currency, electric_current, length,
logarithmic_gain, luminous_intensity, mass, thermodynamic_temperature, time
```
31 On High precision. Using taylor to solve ODE

From: Robert Israel (israel@math.ubc.ca)
Subject: Re: given precision in Maple
Newsgroups: comp.soft-sys.math.maple
Date: 2003-07-16 20:19:06 PST

Set Digits:= n and all calculations from this point will be done with n digits. Mathematical functions will be correct to n digits as well (to the extent this is practical).

If you want high-accuracy numerical ODE solutions, on the other hand, it's not so simple. I think the best way is using the taylorseries method. For example, consider the problem y'=y^2, y(1) = 1, where the exact solution y = 1/(2-x) has y(1.9) = 10.

> Digits:= 30:
> sol:= dsolve({D(y)(x)=y(x)^2, y(1) = 1}, y(x), numeric,
method=taylorseries, abserr=1e-25):
> sol(1.9);

[ x = 1.9, y(x) = 9.99999999999999999999997691]

> 10 - eval(y(x),%);

-23

0.202309 10

The other methods (in particular the default rkf45) do not give results anywhere near this good.

32 How to evaluate catlan number and other sums?

Use the Sum command.

restart;
expr:= (-1)^i/(2*i+1)^2;
Sum(expr,i=0..infinity);
evalf(%,50);
0.91596559417721901505460351493238411077414937428167

Notice, if I used the sum command instead of the Sum command I get this result:

sum(expr,i=0..infinity);
Catalan
33 How to write a text file that contains a package, and load it and execute it?

This shows how to do a simple package and use it without building a library. Just using a plain text file.

Create this nma_pkg1.txt file:

```maple
nma_pkg1 := module()
    export f1;
    option package;

    f1:= proc()
        print("in pakcage nma_pkg1");
    end proc;
end module;
```

now save it, and from maple do

```maple
> read("c:\nma_pkg1.txt");
```

now execute f1() as this:

```maple
>nma_pkg1[f1]();
"in pakcage nma_pkg1"
```

now put it in a library (so that we can use with, instead of read)

```maple
> savelibname:="c:/maple"
> march('create', savelibname, 20)
> savelib(nma_pkg1)
> restart;
> libname := "c:/maple",libname;
> with(nma_pkg1);
> f1();
"in pakcage nma_pkg1"
```

now make changes to the nma_pkg1.txt file and updated again as above.

34 How to find what packages are included in maple

?index,package
35 How to plot the gradient vector field?

```maple
restart;
f:=3*x^2 + y*cos(x*y);
the_grad := linalg[grad](f, [x, y]);
plots[fieldplot](the_grad, x=-2..2, y=-2..2);
```

or

```maple
or can do it in just one command: plots[gradplot](f, x=-2..2, y=-2..2);
```

36 How to put the digits of Pi into a list?

Suppose you want the 100 digits of Pi put in a list. This is one way to do it:

```maple
restart;
L:=evalf(Pi,100);
S:=convert(L,string);
the_list:=seq(parse(S[i]),i=3..length(S));
```

the_list := [1, 4, 1, 5, 9, 2, 6, 5, 3, ..

This below now tells how many times each digits occurs.

```maple
>stats[transform,tally](the_list);
[Weight(0, 8), Weight(1, 8), Weight(2, 12), Weight(3, 11),
Weight(4, 10), Weight(5, 8), Weight(6, 9), Weight(7, 7),
Weight(8, 13), Weight(9, 13)]
```

37 Digits of PI in maple and mma

Written sometime in 2005? I should really record the time when I write something.
I just run these now, August 2014, and now Maple 18 as very fast. So this all below is no longer valid. I will leave it here for now for reference until I update it all later.

I have written a few lines of code, which counts how many times each digit occurs after the decimal points of $\pi$.

Written this in maple first. Then did similar thin in mma 5.0. Both are run on the same PC. No other applications are running at the time when I run the code.

The basic idea of the algorithm is to use `evalf(Pi, digits)` in maple to find $\pi$ for any number of decimal digits, and to use `N[Pi, digits]` in mma for doing the same. (Where the variable digits above is the number of digits)

Then in maple convert the above $\pi$ to a string, and generate a sequence of the characters to right of decimal point, then use `stats[transform, tally]` to do the actual counting.

In mma, I use `RealDigits[]` to get a list of the digits, and then use `Count[]` to do the counting.

This is result of some of the runs to find Pi to some digits, and the total time (to find Pi and do the counting)

All times are in cpu seconds, machine is P4, 2.8 Ghz, 500 MB of RAM, single CPU, hyperthreading enabled, running XP home edition. Maple 9.03 student version, and mma 5.0 student version.

Below is the result, and below that I show the maple code and the mma code.

Because of this, before each run in mma, I exited the application and started it fresh. In maple, it does not matter for the above reason.

<table>
<thead>
<tr>
<th>Digits</th>
<th>Maple 9.0</th>
<th>Mma 5.0</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>100,000</td>
<td>55</td>
<td>0.9</td>
<td>84</td>
</tr>
</tbody>
</table>

Mma is 60 times faster in finding pi and about 56 times faster overall.

<table>
<thead>
<tr>
<th>Digits</th>
<th>Maple 9.0</th>
<th>Mma 5.0</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>300,000</td>
<td>309</td>
<td>3.7</td>
<td>781</td>
</tr>
</tbody>
</table>

Mma is 300 times faster in finding Pi, and 130 times faster overall.

<table>
<thead>
<tr>
<th>Digits</th>
<th>Maple 9.0</th>
<th>Mma 5.0</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,000,000</td>
<td></td>
<td>85</td>
<td>118</td>
</tr>
</tbody>
</table>

Maple time in hours ! Still running.
Maple code

> restart;
startingTime :=time();
L:=evalf(Pi,100000):
timeToFindPiInSecs:=time()-startTime;
S:=convert(L,string):
the_list:=[seq(parse(S[i]),i=3..length(S))]:
stats[transform,tally](the_list);
endTime :=time();
cpuTimeInSecs := endTime - startTime;

mma code

Clear[]
startTime=TimeUsed[]
t1=N[Pi,100000];
timeToFindPiInSecs=TimeUsed[]-startTime
{c,d}=RealDigits[t1];
theList=c[[Range[2,Length[c]]]];
f[digit_]=Count[theList,digit];
{r}=Range[0,9];
Map[f,r]
cpuTimeInSecs=TimeUsed[]-startTime

update 12/25/03 Changed maple code on how to do the counting : To use

StringTools[CharacterFrequencies](S)

Now the counting in maple is much faster. It is always hard to know which is the best function to use.
38  How to find where functions are?

From: Ken Lin (maplemath@tp.edu.tw)
Subject: Re: how to find which package a function belongs to?
Newsgroups: comp.soft-sys.math.maple
Date: 2003-12-04 03:49:26 PST

When Maple first loaded, there are only two kinds of "internal"
commands which can be called directly. One is the "kernal" commands
coded in C, and the other includes many "internal" procedures
programmed by the kernal commands which lies in the "Main Library",
There are also many other "external" procedures which were categorized
into so called "packages", plots[display](...) for example, plots[] is
a package(Library), and display() is the procedure inside plots[]. All
the packages can be loaded by with() command, like
> with(plots);

Because Different Packages include user library might have the same
procedure name, Maple doesn't realize the "procedure_name" you type
in, it took it for a "symbol". If you really want to know which
packages provided by Maple the external procedure lies in, just mark
the procedure_name and press F1 key, the Maple Help Browser will show
you the packages you might be interested.

By the way, plot3d() is a "internal" procedure lies in the Main
Library. You can confirm that by:
> op(0, eval(plot3d));
    procedure
or in Maple 9
> type( plot3d, 'std' );  #Is it internal?   true
> type( plot3d, 'stdlib' ); #Does is lie in "Standard(Main) Library"?
    true
If you are interested the codes inside plot3d()...
> interface(verboseproc=2): #Turn on verboseproc
> print(plot3d); #eval() also works
> interface(verboseproc=1): #Turn off verboseproc

I hope this will give you some help. Have fun with Maple.

Ken Lin

39  on maple data types


40  how to extract stuff from a list based on some selection?

use select. For example
41 how to test if all elements of a matrix are integers?

```plaintext
restart;
m:=Matrix( [[1.3,2,3],[3,4,4]] );
matrixTestQ := proc(m::Matrix)
    local r,c,i,j;
    (r,c):=LinearAlgebra[Dimensions](m);
    for i from 1 to r do
        for j from 1 to c do
            if( not evalb( whattype(m[i,j]) = integer) ) then
                return(false);
            end if;
        end do;
    end do;
    return true;
end proc;
> matrixTestQ(m);
false
```

I am sure there is a better way than the above. Need to find out.

42 how to use laplace transform?

```plaintext
restart;
f:= t->sin(omega*t) ;
L:=convert(inttrans[laplace](f(t),t,s),int);
\[
\frac{\omega}{\omega^2 + s^2}
\]
To find the inverse, do:

inttrans[invlaplace](L,s,t);
```
43 questions I have

Any difference between using
`
diffalg/Rosenfeld_Groebner`\(\text{(args)}\)
or
diffalg[Rosenfeld_Groebner](args)

44 3D plotting

```maple
restart;
f:= (x,y)->x^3-3*x*y^2;
plot3d(f,-1..1,-1..1,numpoints=2500,style=patchcontour);
```

45 How to raise each element in a list to a power?

Use map

```maple
map(`^`,\{1,2,3\},3);
\{1, 8, 27\}
```

46 How to generate a sequence with any increment?

```maple
incr:=.25; start:=0; last:=3;
seq(start+i*incr, i=1..(last/incr));
```
47 What shortcuts are there for matrix manipulation?

read ?MVshortcut, ?MVassignment, and ?Mvextract and Transpose(R) can be shortened to R^%T

48 How to solve a set of equations for the derivative?

Written feb 20, 2004

This is problem 7.4 chapter 4, in the Mary Boas book. Given

\[ \begin{align*}
xs^2 + yt^2 &= 1 \\
x^2 s + y^2 t &= xy - 4
\end{align*} \]

Find \( \frac{dx}{dt}, \frac{dx}{ds}, \frac{dy}{dt}, \frac{dy}{ds} \) at \( x = 1, y = -3, s = 2, t = -1 \)

This is how I did it in maple:

```maple
restart;
alias(x=x(s,t));
alias(y=y(s,t));
alias(Xt= diff(x(s,t), t));
alias(Xs= diff(x(s,t), s));
alias(Yt= diff(y(s,t), t));
alias(Ys= diff(y(s,t), s));

eq1:= x*s^2+y*t^2=1;
eq2:= x^2*s+y^2*t=x*y-4;
r1:=diff(eq1,t);
r2:=diff(eq1,s);
r3:=diff(eq2,t);
r4:=diff(eq2,s);
sol:=solve({r1,r2,r3,r4},{Xt,Xs,Yt,Ys});
```

\[
\begin{align*}
\frac{\partial}{\partial s} x(s, t) &= -\frac{x(s, t) \left( x(s, t) t^2 - 4 y(s, t) st + 2 x(s, t) s \right)}{2 x(s, t) st^2 - 2 y(s, t) ts^2 + x(s, t) s^2 - y(s, t) t^2} \\
\frac{\partial}{\partial t} x(s, t) &= -\frac{y(s, t) t (-3 y(s, t) t + 2 x(s, t))}{2 x(s, t) st^2 - 2 y(s, t) ts^2 + x(s, t) s^2 - y(s, t) t^2} \\
\frac{\partial}{\partial s} y(s, t) &= -\frac{x(s, t) (3 x(s, t) s - 2 y(s, t)) s}{2 x(s, t) st^2 - 2 y(s, t) ts^2 + x(s, t) s^2 - y(s, t) t^2} \\
\frac{\partial}{\partial t} y(s, t) &= -\frac{y(s, t) (4 x(s, t) st - y(s, t) s^2 - 2 y(s, t) t)}{2 x(s, t) st^2 - 2 y(s, t) ts^2 + x(s, t) s^2 - y(s, t) t^2}
\end{align*}
\]
points := {x=1, y=-3, s=2, t=-1};
subs(points, sol);

49 How to solve a set of equations for differentials?

This is problem 7.15 chapter 4 in Boas:

Given $x^2 u - y^2 v = 1$ and $x + y = u v$ Find $\frac{dx}{du}, v$ and $\frac{dx}{du}, y$

This is the maple code to solve this:

```maple
restart;
eq1 := x^2*u - y^2*v = 1;
eq2 := x + y = u*v;
r1 := D(eq1);
r2 := D(eq2);
r1_ := subs(D(v)=0, r1);
r2_ := subs(D(v)=0, r2);
sol := solve({r1_, r2_}, {D(x), D(u)});
print("dx/du,v=");
rhs(sol[1])/rhs(sol[2]);

r1_ := subs(D(y)=0, r1);
r2_ := subs(D(y)=0, r2);
sol := solve({r1_, r2_}, {D(x), D(u)});
print("dx/du,y=");
rhs(sol[1])/rhs(sol[2]);
```

```maple
[eq1 := u^2 - v^2 = 1,
 eq2 := x + y = u*v,
 r1 := 2*D(x)*x*D(u) - 2*D(y)*y*D(v) = 0,
 r2 := D(x) + D(y) = D(u)*v + u*D(v),
 r1_ := 2*D(x)*x*D(u) - 2*D(y)*y*D(v) = 0,
 r2_ := D(x) + D(y) = D(u)*v,
 sol := [D(u) = 2*D(v)*(u*x + y*v)/(2*u*v + x), D(x) = D(v)*(2*y^2 - x^2)/(2*u*v + x) ],
 "dx/du,v=",
 2*(u*x + y*v)/(2*y^2 - x^2),
 r1_ := 2*D(x)*x*D(u) - y^2*D(v) = 0,
 r2_ := D(x) = D(u)*v + u*D(v),
 sol := [D(u) = -D(v)*(2*u^2*x - y^2)/(2*u*v + x), D(x) = D(v)*(u^2 + v*y^2)/(2*u*v + x) ],
 "dx/du,y=",
 -2*u^2*x - y^2/(u*x^2 + v*y^2)]
```
**50 How to plot binary tree**

by [http://www.math.fsu.edu/~bellenot](http://www.math.fsu.edu/~bellenot)

```maple
restart;
t2 := proc(i, x, y)
    if i < 2 then [[x, y], [x, y - 1]], [[x, y], [x + 2^i, y - 1]]
    else [[x, y], [x, y - 1]], [[x, y], [x + 2^i, y - 1]],
    t2(i - 1, x, y - 1), t2(i - 1, x + 2^i, y - 1)
    end if;
end proc;
PLOT(CURVES(t2(6,0,0)));```

---

**51 solving problem 12.4 chapter 4, Math 121A, Boas book. using maple**

```maple
restart;
z:= Int( sin(t)/t, t=sin(x)..cos(x));
diff(z,x);
```

\[
\frac{\sin(x) \sin(\cos(x))}{\cos(x)} - \frac{\cos(x) \sin(\sin(x))}{\sin(x)}
\]
52  example of doing convergence test in maple

```maple
restart;
c:=`c': C:=`C': n:=`n': P:=`P';
C := n -> ((n+2)/(3*n+1))^n:
### WARNING: calls to `C` for generating C code should be replaced by codegen[C]
`The general term is `, c[n]= C(n); ``
The n-th root is:``;
### WARNING: calls to `C` for generating C code should be replaced by codegen[C]
P := C(n)^(1/n):
abs(c[n])^(1/n) = P;
P := simplify(P, assume=positive):
abs(c[n])^(1/n) = P;
```

\[ c_n = \left( \frac{n+2}{3n+1} \right)^n \]

The n-th root is:

\[ |c_n|^{\frac{1}{n}} = \left( \frac{n+2}{3n+1} \right)^{\frac{1}{n}} \]

\[ |c_n|^{\frac{1}{n}} = \frac{n+2}{3n+1} \]

53  Solving problem math 121A, ch 14, 3.18, Boas book. contour integration

```maple
restart;
f:=1/( (1-2*z)*(5*z-4) );
residue(f,z=4/5);
```

\[ -\frac{1}{3} \]

54  How to find multiple roots to an equation such as \( \sin(x) = 0 \)

```maple
_EnvAllSolutions:=true;
solve(sin(x)=0);
```

\[ \pi \_Z1\~ \]
Dear newsgroup:

I had mentioned that my methods will solve classical equations without the use of infinite series.

The following is a Maple code of my old files. Those days I had Maple2 but the general idea is the same in the process and you see that we can also solve the integrals involved.

It does not make sense how are the theory behind it but eventually it will come into light.

Just read the procedures and you can see the solution of associated legendre AL at the end.

> s1:=-diff(p(t),t)+p(t)^2;
> s2:=exp(2*int(p(t),t))*T(t);
> s3:=s1+s2;
> s4:=diff(T(t),t)/T(t);
> s5:=(1/2)*(diff(s4,t))+(1/4)*s4^2;
> s6:=s5+s2;
> p(t):=-1/t+(1)/(2-t);
> s1:=simplify(s1);
> s1:=collect(%,t);
> s2:=simplify(s2);
> s1+s2=(2*t^2-4*t+m^2-1)/(t*(-2+t))^2;
> solve(%,T(t));
> T(t):=simplify(%);
> s2:=simplify(s2);
> s2+s1;
> s3:=simplify(%);
> s6:=simplify(s6);
> t*(-2+t);
> simplify(%);
> z:=(r3*t^3+r2*t^2+r1*t+r0)/(%);
> simplify(diff(z,t)+z^2-s6);
> s7:=collect(numer(%),t);
> coeff(%t,0);
> solve(%r0);
> r0:=op(1,[%]);
> coeff(s7,t,1);
> solve(%r1);
> r1:=simplify(%);
> coeff(s7,t,2);
> solve(%r2);
> r2:=simplify(%);
> coeff(s7,t,3);
> solve(%r3);
> r3:=simplify(%);
> simplify(s7);
The advantage of these methods are that there are ample rooms for advances.

Today my skills for solving classical equations such as Riccati is much advanced.

Highly complicated and more general Riccati equations in its billions now possible.

Sincerely

Dr.M.Basti
Understanding conformal mapping in maple

To plot mapping of complex function in maple, use \texttt{plots\textbackslash conformal}. The trick is to how to specify the quadrant in the x-y plane. This example shows how.

Suppose we want to map the first quadrent. Then we specify the DIAGONAL points in the range, from the lower left corner to the upper right corner, which then should be \(0 \ldots 1+1\) Because 0 is the lower left corner, and \((1, i)\) is the upper right corner. Example:

\begin{verbatim}
restart;
assume(y, real);
assume(x, real);
#f := z -> I + z*exp(I*Pi/4);
f := z -> z^2;
w := f(x + I*y);
u := Re(w);
v := Im(w);
plots:-conformal(f(z), z = 0 .. 1 + I, grid = [16, 16], numxy = [16, 16], scaling = constrained);
\end{verbatim}

This below uses the first TWO quadents, i.e. the upper half of the x-y plane

\begin{verbatim}
restart;
assume(y, real);
assume(x, real);
#f := z -> I + z*exp(I*Pi/4);
f := z -> z^2;
w := f(x + I*y);
u := Re(w);
v := Im(w);
plots:-conformal(f(z), z = -1 - I .. 1 + I, grid = [16, 16], numxy = [16, 16], scaling = constrained);
\end{verbatim}
This below puts the plots next to each others so to see them

```maple
restart;
assume(y,real);
assume(x,real);
f:= z->I+z*exp(I*Pi/4);
#f:= z->z^2;
w:=f(x+I*y);
u:=Re(w);
v:=Im(w);
A := array(1..2):
A[1]:=plots:-conformal(z,z=0..1+I/2,grid=[16,16],numxy=[16,16],scaling=constrained):
A[2]:=plots:-conformal(f(z),z=0..1+I/2,grid=[16,16],numxy=[16,16],scaling=constrained):
plots:-display(A);
```

57 Is there a way to keep the assumptions but not see the tilda character show up?

`interface(showassumed=0)` removes all tildas and `interface(showassumed=1)` adds the tildas.

58 Fourier series in maple

I wrote this to generate FS in Maple for some HW I was doing. I think this was for Math 121A at UC Berkeley in 2003.
restart;
f:=x->piecewise(-Pi<x and x<Pi/2,-1,
    Pi/2<x and x<1,0,1);
assume(n,integer);
nmaFourier2:=proc(f,freq,from_,to_,maxN)
    local n::integer,denomC,denomS,a,b;
    denomC:=( to_ - from_ ) / 2;
    denomS:=( to_ - from_ ) / 2;
    a:=proc(n)
        int(f(x)*cos(n*freq*x),x=from_..to_) / denomC;
    end proc;
    b:=proc(n)
        int(f(x)*sin(n*freq*x),x=from_..to_) / denomS;
    end proc;
    evalf(denomC);
    1/2*a(0) + sum( a(n) * cos(n*freq*x) ,n=1..maxN) + sum( b(n) * sin(n*freq*x) ,n=1..maxN)
    end proc;
r:=[seq(nmaFourier2(f,1,-Pi,Pi,nIter),nIter=1..10)];plot(r,x=-Pi..Pi);

To animate do
g:=n->plot(nmaFourier2(f,1,-Pi,Pi,n),x=-2*Pi..2*Pi);
plots:-animate(g,[n],n=1..40);

Another version
restart;

\[
f(x) = \begin{cases} -1, & -\pi < x < \pi/2 \\ 0, & \pi/2 < x < 1 \\ 1, & 1 < x < \pi, \end{cases}
\]

\textbf{assume(n, integer);} 

\textbf{nmaFourier2:=proc(f,freq,from_,to_,maxN::integer)}
\begin{verbatim}
    local n::integer,denomC,denomS,a,b;
    denomC:=( to_ - from_ ) / 2;
    denomS:=( to_ - from_ ) / 2;
    a:=proc(n)
        int(f(x)*cos(n*freq*x),x=from_..to_) / denomC;
    end proc;
    b:=proc(n)
        int(f(x)*sin(n*freq*x),x=from_..to_) / denomS;
    end proc;
    1/2*a(0) + sum( a(n) * cos(n*freq*x) ,n=1..maxN) + sum( b(n) * sin(n*freq*x) ,n=1..maxN)
end proc;
\end{verbatim}

\textbf{plots\[setoptions\](title=` `, axesfont=[SYMBOL,8] ,font=[COURIER,1],}
\begin{verbatim}
    xtickmarks=[seq(evalf(k*Pi/2)=sprintf("%a %s", k/2,"pi" ),k= -3..3)],
    ytickmarks=[-1.0="-1",-0.5="",0.0="0",0.5="",1.0="1"]);
\end{verbatim}

\textbf{B:=array(1..3,1..3); k:=0;}
\begin{verbatim}
    for i from 1 to 3 do
        for j from 1 to 3 do
            k:=k+1;
            B[i,j]:=plot({f(x),nmaFourier2(f,1,-Pi,Pi,k)},x=-Pi..Pi,size=[200,100]);
        end do;
    end do;
end do;
\end{verbatim}

\textbf{plots:-display( B);}
59  How to plot graphs next to each others in a grid like fashion

```maple
restart;
v:=1;
B:=Matrix(3,3);
for i from 1 to 3 do
  for j from 1 to 3 do
    v:=v+1;
    B[i,j]:= plot(x^v,x=-2..2,thickness=3,size=[200,100] );
  end do;
end do;
plots:-display(B);
```

60  How to generate Pi on X-axis

From book Maple animation by John Putz

```maple
plot( sin(x), x=0..2*Pi, xtickmarks=evalf([Pi/2="p/2", Pi="p", 3*Pi/2="3p/2", 2*Pi="2p"]), ytickmarks=[-1,1], axesfont=[SYMBOL,16], labels=["","" ] );
```
61  How to make output from FunctionAdvisor look better?

From Preben Alsholm

```maple
res:=FunctionAdvisor(sin):
res2:=op(2,eval(res)):
map(print,res2);
```

or answer by Thomas Richard

```maple
> FunctionAdvisor( display, sin );
```

62  How to do partial fractions?

Use convert(expr,parfrac) or convert(f,fullparfrac)

63  How to generate sequence sum symbolically

```maple
n := 7;
f:=sum('a[k]*b[k]','k'=1..n);
```

\[ a_1b_1 + a_2b_2 + a_3b_3 + a_4b_4 + a_5b_5 + a_6b_6 + a_7b_7 \]

64  Nice plot from Maple

from Serge from the net:

```maple
restart;
with(geom3d):
plane(OYZ,x=0,[x,y,z]):
plane(OXZ,y=0,[x,y,z]):
plane(OXY,z=0,[x,y,z]):
c:=1/2:r:=1/4:
L:=combinat[permute]([-c$3,c$3],3):
S:=seq(sphere(s||i,[point(A||i,op(op(i,L))),r]),i=1..8):
draw([OYZ,OXZ,OXY,S]);
```
65  How to check if 2 expressions are the same?

Use evalb(). For example evalb(I*sinh(x)=sin(I*x)); gives true

The above does not always work. Only sure way is to do this

> m1 := exp(I*n*x);
m2 := (cos(n*x)+I*sin(n*x));
simplify(m1-m2);
simplify(m1-convert(m2,exp));

66  converting series to factorials

Function by Robert Israel from the net:
restart;

thefacts:= [seq(i!,i=2..20)];
getfacts:= proc(x::{algebraic,series})
local i;
if type(x, {`+`,`*`,series}) then
    map(getfacts,x)
elif type(x, fraction) then
    getfacts(numer(x))/getfacts(denom(x))
elif type(x,`^`) then
    getfacts(op(1,x))^op(2,x)
elif type(x,negint) then
    -getfacts(-x)
elif type(x,posint) then
    for i from 1 to 19 while irem(x, thefacts[i]) = 0 do od:
    if i = 1 then x
    elif thefacts[i-1] = x then ``(i)!
    else ``(i-1)!*getfacts(x/thefacts[i])
    fi
else x
fi
end;
getfacts(series(sin(x),x));

\[
\text{series}\left( x - \frac{x^3}{(3)!} + \frac{x^5}{(5)!} + O(x^7), x, 7 \right)
\]

67 How to find what new additions made to Maple?

?updates,maple10

68 Why Maple can't solve laplace equation and numerically?

with (PDEtools);
PDE := diff(u(x,y), y, y ) + diff(u(x,y), x, x) = 0;
BC:= u(x,0)=0, u(x,100)=100, u(y,0)=0, u(y,10)=0;
sol:=pdsolve(PDE,{BC} ,numeric  );

Error, (in pdsolve/numeric) initial/boundary conditions must be defined at one or two points for each independent variable
### Some Maple Matrix operations

Create a new matrix, by appending some rows of one matrix to rows from another matrix:

```maple
restart; with(LinearAlgebra):
A:=< 1 2 3 , 4 5 6 >;

B:=< 7 8 10 , 11 12 13 , 14 15 16 >;

Now append first row of A to last 2 rows of B
C:=< A[1,1..-1] , B[2..-1,1..-1] >;

# Now append first column of A to first 2 rows of B
A[1..-1,1];
B[1..2,1..-1];
C:=< A[1..-1,1] | B[1..2,1..-1] >;

# Now remove the middle row of B
B;
B:=<B[1,1..-1] , B[-1,1..-1] >;
```
To find inverse.

```maple
restart;
with(LinearAlgebra):
A:=Matrix( [ [2,0],[4,2] ]); MatrixInverse(A);
```

```
[ 1/2 0 ]
[ -1 1/2 ]
```

To check that for any matrix A, then $A^T \cdot \text{transpose}(A)$ is always a matrix which is symmetrical

```maple
A:=RandomMatrix(2,3); A.Transpose(A);
```

```
A :=
[ 99 44 -31 ]
[ 29 92 67 ]
```

```
[ 99 44 -31 ]
[ 29 92 67 ]
```
how to create a random lower triangular matrix?

```
restart;
with(LinearAlgebra);
A:=RandomMatrix(4,4,outputoptions=[shape=triangular[lower]]);
```

```
\[
\begin{bmatrix}
67 & 0 & 0 & 0 \\
-31 & 92 & 0 & 0 \\
44 & 29 & 99 & 0 \\
69 & 8 & 27 & -4
\end{bmatrix}
\]
```

70 How set diagonal elements to some value, say 1?

```
restart;
with(LinearAlgebra);
A:=RandomMatrix(5);
LinearAlgebra:-Map[(i,j)->evalb(i=j)](x->1,A);
```

```
\[
A := \begin{bmatrix}
1 & -98 & -76 & -4 & 29 \\
-38 & 1 & -72 & 27 & 44 \\
-18 & 57 & 1 & 8 & 92 \\
87 & 27 & -32 & 1 & -31 \\
33 & -93 & -74 & 99 & 1
\end{bmatrix}
\]
```
71 How to multiply roots of a polynomial?

\[
\text{eq} := 3x^3 + 2x^2 + x + 5 = 0; \\
s := \text{evalf(solve(eq,x))}; \\
\text{mul}(s[i], i = 1..\text{nops}(s));
\]

\[
eq \quad 3 x^3 + 2 x^2 + x + 5 = 0 \\
s := [-1.342780428, 0.3380568807 - 1.061566392 I, 0.3380568807 + 1.061566392 I] \\
\quad -1.666666666 - 1.157693742 \times 10^{-10} I
\]

72 How to plot a surface in 3D?

\[
\text{restart;}
\]
\[
\text{eq} := 3x+4y+2z=10; \\
\text{plot3d}(\text{solve(eq,z)}, x=-5..5, y=-5..5, \text{axes=normal});
\]

One can also use \text{implicitplot3d}

\[
\text{restart;}
\text{with(plots):}
\text{implicitplot3d}(3x+4y+2z=10, x=-5..5, y=-5..5, z=-20..20, \text{axes=normal});
\]
73  How to convert trigs to sinc function in an expression

From [http://www.mapleprimes.com/questions/40470-Trigonometric-Function-To-Sinc-Function](http://www.mapleprimes.com/questions/40470-Trigonometric-Function-To-Sinc-Function)

Maple doesn’t have a sinc function. If you mean the function sinc(x) = sin(x)/x, you could say something like

```
> eval(expr, {sin = (x -> x*sinc(x)),
             cos = (x -> (x+Pi/2)*sinc(x+Pi/2)),
             tan = (x -> x*sinc(x)/(x+Pi/2)/sinc(x+Pi/2))});
```

74  How to find NullSpace and ColumnSpace of a matrix?

```
restart;
with(LinearAlgebra):
A:=Matrix([[1,0,1,0,1],[0,1,0,1,0]]);
NullSpace(A);
ColumnSpace(A);
```
75 How to fix the interface to using Maple notation for input?

Go to tools->option, and Display, and select Maple notation for input display.

76 How to find all solutions using allvalues?

\[
\begin{bmatrix}
1 & 0 & 1 & 0 & 1 \\
0 & 1 & 0 & 1 & 0 \\
-1 & 0 & -1 & 0 \\
0 & -1 & 0 & 1 \\
0 & 0 & 1 & 0 \\
1 & 0 & 0 & 0 \\
1 & 0 & 0 & 1 \\
0 & 0 & 1 & 1
\end{bmatrix}
\]

\[
solve(x^2-sin(x),x);
\]

RootOf(-sin(_Z)+_Z^2)

allvalues(%);
RootOf(-sin(_Z)+_Z^2, 0.), RootOf(-sin(_Z)+_Z^2, .8767262154)

evalf(%);
0., .8767262154

77 How to add one to only the elements of the diagonal of a matrix?

Use Map with filter

\[
A:=< 1,2,3;4,5,6;7,8,9>;
\]

LinearAlgebra:-Map[(i,j)->evalb(i=j)](x->x+1,A);

78 How to search help for updates on some package

Go to [http://www.maplesoft.com/support/help/search.aspx](http://www.maplesoft.com/support/help/search.aspx) and type say updates,Maple17,DE in the small box there.
79  How to work with groups in worksheet

From http://www.mapleprimes.com/questions/201092-How-To-Insert-New-Paragraph-On-Its-Own by Carl Love:

I use these special keystrokes constantly in my Maple worksheet typing:

- Ctrl-J: Insert execution group below cursor.
- Ctrl-K: Insert execution group above cursor.
- Ctrl-T: Switch from executable code mode to text mode (for entering extended formatted comments).
- Ctrl-M: Switch from text mode to executable code mode.
- Shift-Enter (or Shift-Return): Begin a new line in the same execution group.
- Func-3: Split execution group into two (at cursor).
- Func-4: Join cursor execution group with execution group below.

80  How to read code into worksheet?

Use the read command, as in read "mycode.mpl" where mycode.mpl is plain text file that contains maple code

81  Code editors for Maple


82  How to find if package is module or table?

New packages are module, which allows using packageName:-function() since it is easier. Old packages use tables which needs packageName[function]() which is not common.

To find if package is based on module or not, use the command

```
type(combstruct,`module`);
```

This will return true or false. To know if name is package use the command

```
type(combstruct,'package');
```
83  How to replace a string?

```latex
file_name := StringTools:-SubstituteAll(file_name, ":", ":-"));
```

84  How to use geometry and plottools ?

```latex
restart;
c:= i->([[i/(1+i),0],1/(1+i)):
d:= i->([[1,1/i]],1/i):
geometry:-circle(c1,[geometry:-point(o,2/3,0),1/3],[x,y]):
geometry:-circle(c2,[geometry:-point(o,1,1),1],[x,y]):
geometry:-intersection(o,c1,c2,[u,v]):
plots:-display(plottools:-circle(c2),plottools:-circle(d1),geometry:-draw(o));
```

To know more about the intersection, use this:

```latex
geometry:-detail(o);
```

85  How to simplify log expressions ?

Use symbolic option

```latex
restart;
simplify(ln(3^x/2^y) =ln(n),symbolic);
```

86  How to simplify hyperbolic expression ?

How to convert

\[
\frac{3 + 2 \sinh(x)^2}{\sinh(x)^2 \tanh(x)}
\]

to

\[
3 \coth^3(x) - \coth(x)
\]

```latex
restart;
e := (3+2*\sinh(x)^2)/(\sinh(x)^2*\tanh(x));
expand(student[changevar](\sinh(x)^2=\tanh(x)^2/(1-\tanh(x)^2),e));
```
87  How to create text file and append string to it?

```plaintext
code

restart;
try
  fd :=-1;
  fd := fopen("C:\\output3.txt",APPEND,TEXT);
catch:
  print(`Unable to open file, error is`);
  print(StringTools:-FormatMessage(lastexception[2]));
end try:

if not(evalb(fd=-1)) then #file open ok
  str:="hello world"
  try
    fprintf(fd,"%s\n",str);
    catch:
      print(`failed to append to file, error is`);
      print(StringTools:-FormatMessage(lastexception[2]));
    finally:
      close(fd);
    end try;
  fi:
```

88  How to search packages and libraries?

To find in which library a command is do

```plaintext
code

with(LibraryTools);
FindLibrary('int',all); #find which library command int is in

"C:\Program Files\Maple 18\lib\update.mla",
"C:\Program Files\Maple 18\lib\DEsAndMathematicalFunctions18.mla",
"C:\Program Files\Maple 18\lib\maple.mla"
```

To get content of library do

```plaintext
code

restart;
with(LibraryTools):
LibLocation:=cat(kernelopts(mapledir),"/lib/maple.mla");
c:=ShowContents(LibLocation);
```

Then can use this to print the name of each symbol/command, and then use whattype command to find its type

```plaintext
code

seq(c[i,1],i=1..20);
```
To get list of Maple kernel builtin commands and symbols, use this. Written by Acer from Maple prime site:

```maple
restart;
interface(warnlevel=0):
started := false:
T := 'T':
for i from 1 to 1000 do
    f := eval(parse(cat("proc() option builtin=",i,"; end proc")));
    p := (s->StringTools:-Take(s,StringTools:-Search(";",s)-1))(convert(eval(f),string)[26..]);
    if not type(parse(p),posint) then
        T[i] := p;
        started := true;
    else
        if started then i:=1000; next; end if;
    end if;
end do:
i;
[ entries(T,nolist) ];
nops(%);
```

The above gives on Maple 18.02 the following:

```maple
"crinterp", "equation", "\{}\"", "even", "debugopts",
"embedded_imaginary", "define_external", "embedded_real",
"coefficient", "cx_zero", "coeffs", "embedded_axis", "conjugate",
"constant", "convert", "cx_infinity", "dllclose", "identical",
"divide", "hfarray", "done\"", "function", "\$\"", "fraction",
"denom", "float", "degree", "finite", "disassemble",
"extended_rational", "diff", "extended_numeric", "frem",
"union", "frontend", "upperbound", "exports", "writeto",
"factorial", "xor", "evalgf1", "type", "expand", "typematch",
"entries", "unames", "evalb", "unbind",
"evalhf/hypergeom/kernel\", "atomic", "hfarray", "anything",
"hastype", "complex\", "has", "boolean", "goto", "\"\"",
"gmp_isprime", "\"!\"", "genpoly", "anyfunc", "gc", "algebraic",
"SFloatMantissa", "\"system\", "Scale10", "\" stop ", "Scale2",
"sort", "SearchText", "\"\"", "\"\~\"", "subset\", "~Array",
"subsindets", "~Matrix", "streamcall", "~Vector", "subs",
"Unordered", "table", "ToInert", "system",
"_hackwareToPointer", "substring", "UpdateSource", "subop",
"_maplet", "trunc", "_jvm", "kernel/transpose\", "_treeMatch",
"tcoeff", "_savelib", "taylor", "abs", "rtable_num_dims",
"addressof", "rtable_num_elms", "_unify", "rtable_options",
"_xml", "rtable_redim", "\" and \"", "rtable_scale", "andmap",
"rtable_scanblock", "alias", "rtable_size", "anames",
"rtable_sort_indices", "assign", "savelib", "assemble",
"rtable_zip", "array", "select", "appendto", "searchtext",
"cat", "series", "callback", "selectremove", "bind", "sign",
"attributes", "setattribute", "ormap", "ArrayOfOptions", "order",
"Array", "parse", "**", " overload", "**", "\"", "numerator",
"CopySign", "numelems", "\"\"", "or\", "\"\"", "op", "nops",
"seq", "normal", "time\", "\" not\"", "piecewise", "numboccur",
"\"\"\"\","userinfo", "modp2", "inner", "mods", "timelimit",
"mxMultiply", "traperror", "negate", "rtable_normalize_index",
"call_external", "rtable_is_zero", "assigned", "rtable_indfns",
"evalhf", "rtable_histogram", "eval", "evalhf", "rtable_eval",
"truefalse", "evalhf", "rtable_convolution", "tabular", "mul",
"rtableInfo", "zppoly", "\" if \"", "rtable", "uneval", "remove",
```

52
89  How to numerically solve a BVP ode and plot the solution?

This one has one solution

```maple
eq := \text{diff}(u(z),z^2)+(k-1)\cdot \text{diff}(u(z),z)/z+\lambda \cdot \exp(u(z))=0;
sol:=\text{dsolve}([\text{subs}([k=1, \lambda = 2\}, \text{eq}), u(0)=1, u(1)=0], \text{numeric}, u(z), \\
\text{method=bvp[midrich]}, '\text{abserr'}=0.001);
plots[\text{odeplot}](sol);
```

This solved coupled ODE's, so there are 2 solutions. Say \( x_1(t) \) and \( x_2(r) \), It is a little tricky to plot all solutions generated, but here is an example

```maple
restart;
R := 0.4; px := 32000; Mm := 0.1; Ds := 9; DO2 := 7.2; YXS := 0.3; KS := 10;
Sp := 30; Cb := 8; K02 := 0.2; R0 := 0.000001; YXO := 0.42857;
Vs := px*1/YXS*(Mm*x2(r))/(KS + x2(r))*x1(r)/(KO2 + x1(r));
Vo := px*1/YXO*(Mm*x2(r))/(KS + x2(r))*x1(r)/(KO2 + x1(r));
eqs := \text{diff}(x1(r),r^2) + 2/r \cdot \text{diff}(x1(r),r)= \text{Vo}/\text{DO2},
\text{diff}(x2(r),r^2) + 2/r \cdot \text{diff}(x2(r),r)= \text{Vs}/\text{Ds};
ic := \text{dsolve}([\text{eq}, \text{subs}([\text{abserr'}=0.52, '\text{maxmesh'}=1000, \text{output}=\text{listprocedure}]);
```

And now to plot do
x1Sol:=rhs(sol[2]);
plot(x1Sol(r),r=0..0.4);

x2Sol:=rhs(sol[4]);
plot(x2Sol(r),r=0..0.4);

90 How to find the indicial equation for an ODE?

For say Bessel ode of order zero:

eq:= x^2*diff(y(x),x$2)+x*diff(y(x),x)+x^2*y(x)=0;
DEtools[indicialeq](eq,x,0,y(x));
#x^2 = 0

The third argument above is the singularity point of interest. So we have two roots, both zero. These
are now used for finding the power series solution y(x) if needed.

Another example, is Bessel of order 1

eq:= x^2*diff(y(x),x$2)+x*diff(y(x),x)+(x^2-1)*y(x)=0;
DEtools[indicialeq](eq,x,0,y(x));
#x^2-1 = 0

91 How to display on screen for specific width?

This below by [Axel Vogt](sci.math.symbolic) posted on sci.math.symbolic which does a nice job of formatting
output to specific width.
split_for_print:=proc(expr, len)
    # expr = some Maple expression
    # len  = length to split with line breaks
    local L,s,tmp,j;
    s:=convert(expr, string);
    L:=[StringTools:-LengthSplit(s, len)];
    for j from 1 to nops(L) do
        # if j = nops(L) then printf("%s ;", L[-1])
        if j = nops(L) then printf("%s", L[-1])
        else printf("%s\\n", L[j]);
        end if;
    end do:
end proc;

evalf[100](Pi);
split_for_print(%, 40);

3.14159265358979323846264338327950288419\n7169399375105820974944592307816406286208\n998628034825342117068

92  Maple IDE links

for VIM

1. [https://code.google.com/p/maplevim/source/browse/trunk/syntax/maple.vim](https://code.google.com/p/maplevim/source/browse/trunk/syntax/maple.vim)

in vim, type set syntax=maple after putting the file maple.vim in ~/.vim/syntax/maple.vim. I found maple.vim in above link.

For Maple IDE

MapleIDE18

93  loading, remove and finding what packages loaded

use packages(); to find what packages loaded. use unwith to remove package
94 some rules of thumbs when using Maple

1. put restart in separate execution group

2. do not use with inside proc(). Use uses instead.

95 How to write derivative

To write $y'(x) = x$, one way is $\text{diff}(y(x), x) = x$ and another is $D(y)(x) = x$. To write $y''(x) = x$, one way is $\text{diff}(y(x), x$2) = x and another is $(D@@2)(y)(x) = x$.

To convert from one form to another use convert(eq, diff) or convert(eq, D)

96 How to solve heat PDE in 1D in Maple 2017?

To solve $\frac{\partial u(x,t)}{\partial t} = k \frac{\partial^2 u(x,t)}{\partial x^2}$ with homogeneous dirichlet boundary conditions $u(0, t) = 0, u(L, t) = 0$, the commands are

```maple
restart; 
pde:=diff(u(x,t),t)=k*diff(u(x,t),x$2); 
bcs:=u(0,t)=0,u(L,t)=0; 
sol:=pdsolve([pde,bcs]) assuming 0<L;
```

Which gives

$$u(x,t) = \sum_{Z1=1}^{\infty} C1(Z1) \sin \left( \frac{\pi \cdot Z1 \cdot x}{L} \right) e^{-\frac{k \pi^2 \cdot Z1^2 \cdot t}{L^2}}$$

Which can be made more readable as follows

```maple
sol:=algsubs(_Z1=n,sol):
sol:=algsubs(Pi*n/L=lambda(n),sol);
```
\[ u(x, t) = \sum_{n=1}^{\infty} C_1(n) \sin (x\lambda(n)) e^{-k(t\lambda(n))^2} \]

For homogeneous Neumann B.C., at \( x = 0 \) let \( \frac{\partial u}{\partial x} = 0 \) and at \( x = L \) let \( u(L, t) = 0 \), the solution it gives looks different than my hand solution.

```
restart;
pde:=diff(u(x,t),t)=k*diff(u(x,t),x$2);
bc:=D[1](u)(0,t)=0,u(L,t)=0;
pdsolve([pde,bc]) assuming 0<L;
```

It gives

\[ u(x, t) = \sum_{n=1}^{\infty} C_1(n) \sin (x\lambda(n)) e^{-k(t\lambda(n))^2} \]

I need to look more into the above and see if this comes out to be the same as my hand solution.

Another example, with initial conditions now given

```
restart;
pde:=diff(u(x,t),t)=k*diff(u(x,t),x$2);
bc:=D[1](u)(0,t)=0,u(L,t)=0;
ic:=u(x,0)=f(x);
sol:=pdsolve([pde,bc,ic],u(x,t)) assuming 0<L;
sol1:=algsubs(_Z2=n,sol);
```

The result is

\[ u(x, t) = \sum_{n=1}^{\infty} \frac{1}{L} e^{-1/4 \frac{k\pi^2(n+1)^2}{L^2}} \cos \left( \frac{1}{2} \frac{\pi x (1 + 2n)}{L} \right) \int_0^L f(x) \cos \left( \frac{1}{2} \frac{\pi x (1 + 2n)}{L} \right) dx \]

Another example

```
restart;
pde:=diff(u(x,t),t)=k*diff(u(x,t),x$2);
bc:=D[1](u)(0,t)=0,u(L,t)=0;
ic:=u(x,0)=3* \sin(Pi*x/L)-\sin(3*Pi*x/L);
sol:=pdsolve([pde,bc,ic],u(x,t)) assuming 0<L;
sol1:=algsubs(_Z2=n,sol);
```

\[ u(x, t) = \sum_{n=1}^{\infty} \frac{1}{\pi (16 n^4 + 32 n^3 - 136 n^2 - 152 n + 105)} e^{-1/4 \frac{k\pi^2(n+1)^2}{L^2}} \cos \left( \frac{1}{2} \frac{\pi x (1 + 2n)}{L} \right) \]

Another example
restart;
pde:=diff(u(x,t),t)=k*diff(u(x,t),x$2);
bcs:=u(0,t)=0,u(L,t)=0;
ic:=u(x,0)=3*sin(Pi*x/L)-sin(3*Pi*x/L);
sol:=pdsolve([pde,bc,ic],u(x,t)) assuming 0<L;

\[
\begin{align*}
  u(x,t) &= \sin\left(\frac{\pi x}{L}\right) e^{-9 \frac{\pi^2 k t}{L^2}} \left(-2 \cos\left(\frac{2 \pi x}{L}\right) + 3 e^{8 \frac{\pi^2 k t}{L^2}} - 1\right)
\end{align*}
\]

The above answer seems wrong. There is not even a summation in it. It is different from my hand solution. Look more into it.

97 How to make multiple assumptions on a symbol?

```maple
assume( A::AndProp(NonZero,constant) );
```

Now can use `is(A,constant);`

98 How to make Maple display `diff(y(x),x)` as \( y'(x) \) ?

Add this

```maple
Typesetting:-Settings(typesetprime=true, prime=x):
```

99 How to check if expression is an equation?

Check for `=` as follows

```maple
eq:= x=1;
whattype(eq);  # `=`
if whattype(eq) = `=` then
  print("yes");
else
  print("no");
fi;
"yes"
```

100 How to check if expression is a set?

Check for `set` as follows
eq := {diff(y(x),x)=1, x(0)=1};

if whattype(eq) = `set` then
    print("yes");
else
    print("no");
fi;

"yes"

101 How to set boundary conditions for dsolve or pdsolve?

The Maple syntax for setting initial and boundary conditions is very confusing, as compared to Mathematica, which seems to me to be simpler. So I wrote this to remind me of the syntax each time.

For PDE, assuming dependent variable is \( u(x, t) \) then

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Maple code</th>
</tr>
</thead>
<tbody>
<tr>
<td>( u(0, t) = 0 )</td>
<td>( u(0, t) = 0 )</td>
</tr>
<tr>
<td>( \frac{\partial u}{\partial x} = 0 ) at ( x = 0 )</td>
<td>( D<a href="u">1</a>(0, t) = 0 )</td>
</tr>
<tr>
<td>( \frac{\partial^2 u}{\partial x^2} = 0 ) at ( x = 0 )</td>
<td>( D<a href="u">1, 1</a>(0, t) = 0 )</td>
</tr>
<tr>
<td>( \frac{\partial^3 u}{\partial x^3} = 0 ) at ( x = 0 )</td>
<td>( D<a href="u">1, 1, 1</a>(0, t) = 0 )</td>
</tr>
<tr>
<td>( \frac{\partial u}{\partial t} = 0 ) at ( t = 0 )</td>
<td>( D<a href="u">2</a>(x, 0) = 0 )</td>
</tr>
<tr>
<td>( \frac{\partial^2 u}{\partial t^2} = 0 ) at ( t = 0 )</td>
<td>( D<a href="u">2, 2</a>(x, 0) = 0 )</td>
</tr>
<tr>
<td>( \frac{\partial^3 u}{\partial t^3} = 0 ) at ( t = 0 )</td>
<td>( D<a href="u">2, 2, 2</a>(x, 0) = 0 )</td>
</tr>
</tbody>
</table>

Notice the syntax for the last one above. It is \( (D[1] @@ 2)(u)(0, t) = 0 \) and not \( (D @@ 2)[1](u)(0, t) = 0 \).

For an ODE, assuming dependent variable is \( y(x) \) then the syntax is

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Maple code</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y(0) = 0 )</td>
<td>( y(0) = 0 )</td>
</tr>
<tr>
<td>( \frac{dy}{dx} = 0 ) at ( x = 0 )</td>
<td>( D(y)(0) = 0 )</td>
</tr>
<tr>
<td>( \frac{d^2 y}{dx^2} = 0 ) at ( x = 0 )</td>
<td>( (D @@ 2)(y)(0) = 0 )</td>
</tr>
</tbody>
</table>

102 How to export a plot to PDF?

I could only find a way to export to eps
Make sure not to put : at the end of the plot command! else it will not be exported. It has to end with ;

This will same it to t.eps in the currentdir() location. Then used ps2pdf  t.eps  t.pdf to convert it to PDF. Or just ps2pdf  t.eps it will automatically create t.pdf

Or ps2pdf -dCompatibilityLevel=1.4  t.eps but may it is best to do

ps2pdf -dCompatibilityLevel=1.4 -dEmbedAllFonts=true  t.eps

Also try adding

-dPDFSETTINGS=/printer

to the above. This tells it to optimize it for printing.

Another example of a direction field for an ODE

103  How to find all roots of complex number

To find roots of $(3 + 4i)^{1/3}$, do

```plaintext
fsolve(z^3=(3+4*I),z);
#gives
-1.26495290635775+1.15061369838445*I,
-.363984239564424-1.67078820068900*I,
1.62893714592218+.520174502304545*I
```