my Maple cheat sheet

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Contents

1 How to find a particular solution to ODE?

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

To step into the code, do

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

To print it do

```
print(`DEtools/particularsol`);
```

2 How to find basis solutions for homogeneous ode?

Use the `output=basis` option

```
ode:=diff(y(x),x$2)-x*diff(y(x),x)-x*y(x)=0;
dsolve(ode,output=basis);
```

3 How to convert Mathematica expression to Maple?

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

Or

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

4 How to debug internal procedures, such as dsolve?

```
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 up. Did `step` command and now it steps inside `dsolve`

5 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.

6 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:
```

See `http://www.mapleprimes.com/questions/35951-How-To-Debugtrace-Things-In-Maple`

Also look at `kernelopts(opaquemodules=true)`

Here is a useful post by Carl Love 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

   ```
   infolevel[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:

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

3. Trace the execution of particular procedures with trace:

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

4. Trace the execution of everything with printlevel:

   ```
   printlevel:= 10000:
   ```

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

7 How to display a build in function code?

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

Or to see line numbers

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

Or can use the `Browse();` command

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

Another option I found is

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

Then the above produces listing that can be copied as string with line wrapping ok.

8 How to build a LIST or a SET on the fly?

One way

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

But a better way is to use `seq`

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

       L := [1, 2, 3]
```

9 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
```

10 How to solve a differential equation with initial conditions?

To solve

$$y'' - 3y' + 2y = 10e^{5x}$$

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

```
eq1:= diff(y(x),x$2)-3*diff(y(x),x)+2*y(x)=10*exp(5*x);
dsolve({eq1,y(0)=1,D(y)(0)=5},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
....
```

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

```
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));
```

11 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
```

12 How to know the type of ODE?

Maple can classify the ODE.

```
eq1:= diff(y(x),x$2)-3*diff(y(x),x)+2*y(x)=10*exp(5*x);
R0 := DEtools['odeadvisor'](eq1,y(x));

        R0 := [[_2nd_order, _with_linear_symmetries]]
```

To get help on this type of ODE, do

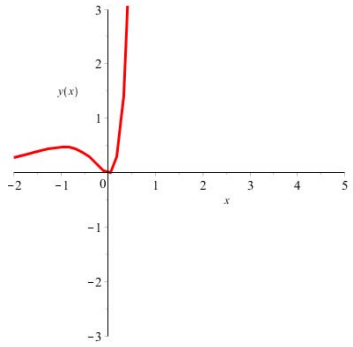
```
DEtools['odeadvisor'](eq1,'help');
```

13 What packages to load for differential equations?

Use `with(DEtools);`

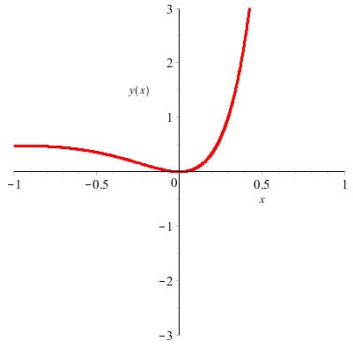
14 How to plot solution of differential equations?

```
restart;
eq1:= diff(y(x),x$2)-3*diff(y(x),x)+2*y(x)=10*exp(5*x);
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

```
restart;
eq1:= diff(y(x),x$2)-3*diff(y(x),x)+2*y(x)=10*exp(5*x);
DEtools[DEplot](eq1,y(x),x=-1..1,[[y(0)=0,D(y)(0)=0]],y=-3..3,stepsize=0.001,
   linecolor=red);
```

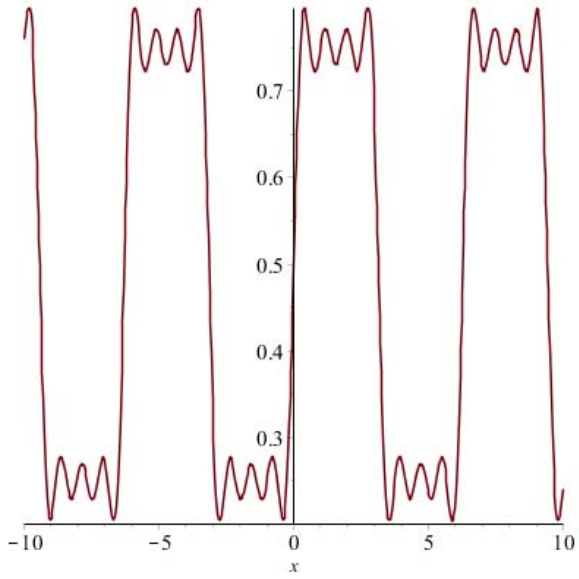


15 How to plot a function?

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

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);
```



16 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.

17 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];
```

$$\begin{bmatrix} 2 \\ 6 \\ 6 \end{bmatrix}$$

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:

```
LL:= [[1,2], [3,4]];
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.)

```
L:= []; # Create a NULL sequence
do
   line:= readline(file);
   if line::string then
      if line contains valid data then
         Z:= a list of that data;
         L:= L, Z
      fi
   else
      break
   fi
od

A:= Matrix([L]); # Note []: seq -> list.
```

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

A;

$$\begin{bmatrix} 1 & 2 & 3 \\ 3 & 6 & 7 \\ 5 & 6 & 9 \\ 7 & 7 & 7 \end{bmatrix}$$

```
B:=A[1..row,2];
```

$$\begin{bmatrix} 2 \\ 6 \\ 6 \\ 7 \end{bmatrix}$$

```
A[1..row,3]:=B: A;
```

$$\begin{bmatrix} 1 & 2 & 2 \\ 3 & 6 & 6 \\ 5 & 6 & 6 \\ 7 & 7 & 7 \end{bmatrix}$$

18 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:

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

19 How does maple handle procedure arguments?

When passing a variable to maple procesure, 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 `x:=1`

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

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

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

      f := 6
```

20 How to define your own data types?

Use `type/name` to define new type name.

```
`type/char`:= x-> x::string and length(x)=1;

P:= proc(c::char) print(c) end proc:
P("x");
                            "x"
P("xy");
Error, invalid input: P expects its 1st argument, c, to be of type char, but
    received xy

> `type/byte`:= x-> x::integer and (x>= 0 and x<256);

will define a byte (unsigned integer)
```

21 How to find max element in a matrix and its position as same time?

Code from net by Carl Devore:

```
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`

```
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];
```

22 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
How-To-Create-A-Personal-Package

23 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

24 How to find taylor series expansion of functions?

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

$$x - 1/6\,x^3 + \frac{x^5}{120} - \frac{x^7}{5040} + \frac{x^9}{362880}$$

25 How to print elements of a matrix?

```
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
```

26 How to find determinant of matrix?

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

27 How to generate Hilber matrix?

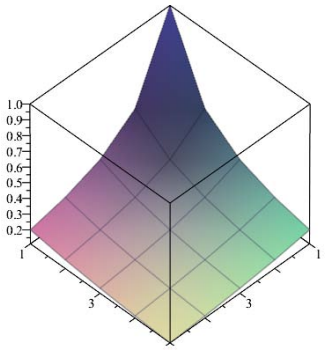
```
H := LinearAlgebra:-HilbertMatrix(5);
```

$$\begin{bmatrix} 1 & 1/2 & 1/3 & 1/4 & 1/5 \\ 1/2 & 1/3 & 1/4 & 1/5 & 1/6 \\ 1/3 & 1/4 & 1/5 & 1/6 & 1/7 \\ 1/4 & 1/5 & 1/6 & 1/7 & 1/8 \\ 1/5 & 1/6 & 1/7 & 1/8 & 1/9 \end{bmatrix}$$

28 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);
```



29 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:=MMax(4);
catch:
   printf("an error is cought\n");
end try;
```

30 How to convert 3456 to 3,456 ?

From the net, by Carl Devor:

```
`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))`

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

Now can use the string as normal array

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

31 How to use units ?

```
Units[GetDimensions](base);
 amount_of_information, amount_of_substance, currency, electric_current, length,
 logarithmic_gain, luminous_intensity, mass, thermodynamic_temperature, time
```

32 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) = 9.99999999999999999999999797691]

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

                                      -23
                          0.202309 10
```

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

33 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
```

34 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:

```
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

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

now execute f1() as this:

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

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

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

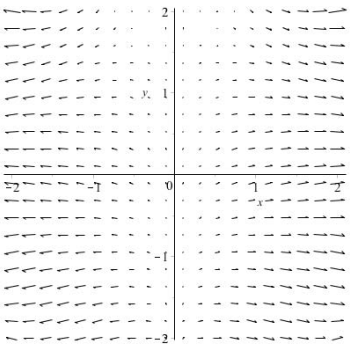
now make changes to the `nma_pkg1.txt` file and updated again as above.

35 How to find what packages are included in maple

```
?index,package
```

36 How to plot the gradiant vector field?

```
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

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

37 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:

```
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.

```
>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)]
```

38 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, Auust 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 π

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 π 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 π 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, hyper-threading 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.

100,000 digits:

	Find_Pi	Total
Maple 9.0	55	84
Mma 5.0	0.9	1.54

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

300,000 digits:

	Find_Pi	Total
Maple 9.0	309	781
Mma 5.0	3.7	6

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

3,000,000 digits		
	Find_Pi	Total
Maple 9.0		
Mma 5.0	85	118

Maple time in hours ! Still running.

Maple code

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

mma code

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

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.

```
restart;
 startingTime :=time();
 L:=evalf(Pi,300000):
 timeToFindPiInSecs:=time()-startingTime;
 S:=convert(L,string):
StringTools[CharacterFrequencies](S);
endingTime :=time():
cpuTimeInSecs := endingTime - startingTime;
```

39 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" prodecures 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 prodecure 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

40 on maple data types

See http://www.maplesoft.com/applications/view.aspx?SID=1533&view=html&L=G

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

use select. For example

```
>restart;
>my_list:=[1,3.4,3+I,5];
>select(x->evalb(Im(x)=0),my_list);
        [1, 3.4, 5]
```

42 how to test if all elements of a matrix are integers?

```
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.

43 how to use laplace transform?

```
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);
```

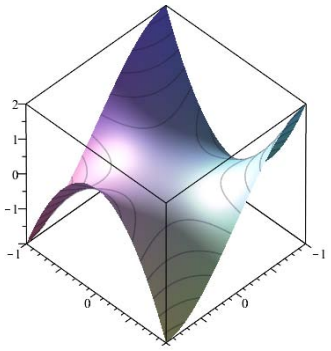
$$\sin(\omega\, t)$$

44 questions I have

```
Any difference between using

`diffalg/Rosenfeld_Groebner`(args)
or
diffalg[Rosenfeld_Groebner](args)
```

45 3D plotting

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



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

Use map

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

47 How to generate a sequence with any increment?

```
incr:=.25; start:=0; last:=3;
seq(start+i*incr,i=1..(last/incr));
```

48 What shortcuts are there for matrix manipulation?

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

49 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

$$xs^2 + yt^2 = 1$$
$$x^2s + y^2t = xy - 4$$

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:

```
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});
```

$$\frac{\partial}{\partial s}x(s,t) = -\frac{x(s,t)\left(x(s,t)t^2 - 4y(s,t)st + 2x(s,t)s\right)}{2x(s,t)st^2 - 2y(s,t)ts^2 + x(s,t)s^2 - y(s,t)t^2}$$
$$\frac{\partial}{\partial t}x(s,t) = -\frac{y(s,t)t\left(-3y(s,t)t + 2x(s,t)\right)}{2x(s,t)st^2 - 2y(s,t)ts^2 + x(s,t)s^2 - y(s,t)t^2}$$
$$\frac{\partial}{\partial s}y(s,t) = -\frac{x(s,t)\left(3x(s,t)s - 2y(s,t)\right)s}{2x(s,t)st^2 - 2y(s,t)ts^2 + x(s,t)s^2 - y(s,t)t^2}$$
$$\frac{\partial}{\partial t}y(s,t) = -\frac{y(s,t)\left(4x(s,t)st - y(s,t)s^2 - 2y(s,t)t\right)}{2x(s,t)st^2 - 2y(s,t)ts^2 + x(s,t)s^2 - y(s,t)t^2}$$

```
points:= {x=1,y=-3,s=2,t=-1};
subs(points,sol);
```

50 How to solve a set of equations for differentials?

This is problem 7.15 chapter 4 in Boas:

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

This is the maple code to solve this:

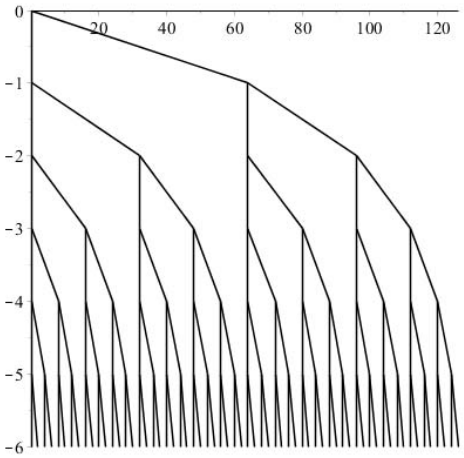
```
restart;
eq1:=x^2*u-y^2*v=1;
eq2:=x+y=u*v;
r1:=D(eq1);
r2:=D(eq2);
r1_:=subs(D(v)=0,r1);
r2_:=subs(D(v)=0,r2);
sol:=solve({r1_,r2_},{D(x),D(u)});
print("dx/du,v=");
rhs(sol[1])/rhs(sol[2]);

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]);
```

$$eq1 := u\,x^2 - v\,y^2 = 1$$
$$eq2 := x + y = u\,v$$
$$r1 := 2\,\mathrm{D}(x)\,x\,u + x^2\,\mathrm{D}(u) - 2\,\mathrm{D}(y)\,y\,v - y^2\,\mathrm{D}(v) = 0$$
$$r2 := \mathrm{D}(x) + \mathrm{D}(y) = \mathrm{D}(u)\,v + u\,\mathrm{D}(v)$$
$$r1\_ := 2\,\mathrm{D}(x)\,x\,u + x^2\,\mathrm{D}(u) - 2\,\mathrm{D}(y)\,y\,v = 0$$
$$r2\_ := \mathrm{D}(x) + \mathrm{D}(y) = \mathrm{D}(u)\,v$$
$$sol := \left\{\mathrm{D}(u) = \frac{2\,\mathrm{D}(y)\,(u\,x + v\,y)}{x\,(2\,u\,v + x)},\ \mathrm{D}(x) = \frac{\mathrm{D}(y)\,\left(2\,v^2\,y - x^2\right)}{x\,(2\,u\,v + x)}\right\}$$
"dx/du,v="
$$\frac{2\,(u\,x + v\,y)}{2\,v^2\,y - x^2}$$
$$r1\_ := 2\,\mathrm{D}(x)\,x\,u + x^2\,\mathrm{D}(u) - y^2\,\mathrm{D}(v) = 0$$
$$r2\_ := \mathrm{D}(x) = \mathrm{D}(u)\,v + u\,\mathrm{D}(v)$$
$$sol := \left\{\mathrm{D}(u) = -\frac{\mathrm{D}(v)\,\left(2\,u^2\,x - y^2\right)}{x\,(2\,u\,v + x)},\ \mathrm{D}(x) = \frac{\mathrm{D}(v)\,\left(u\,x^2 + v\,y^2\right)}{x\,(2\,u\,v + x)}\right\}$$
"dx/du,y="
$$-\frac{2\,u^2\,x - y^2}{u\,x^2 + v\,y^2}$$

51 How to plot binary tree

by http://www.math.fsu.edu/~bellenot

```
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)));
```



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

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

$$-\frac{\sin(x)\sin(\cos(x))}{\cos(x)}-\frac{\cos(x)\sin(\sin(x))}{\sin(x)}$$

53 example of doing convergence test in 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;
```

The general term is , $c_n=\left(\frac{n+2}{3\,n+1}\right)^n$

The n-th root is:

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

$$|c_n|^{\frac{1}{n}}=\frac{n+2}{3\,n+1}$$

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

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

$$\frac{-1}{3}$$

55 How to find multiple roots to an equation such as $sin(x) = 0$

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

```
Pi _Z1~
```

56 Dr Basti Associated Legendre

Subject:	Associated Legendre
Author:	Mehran Basti <Basti@worldnet.att.net>
Organization:	AT&T Worldnet
Date:	Mon, 25 Nov 2002 02:48:15 GMT

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);
> s3:=simplify(s3);
> s4:=simplify(s4);
> s6:=simplify(s6);
> T(t):=simplify(T(t));
> z:=simplify(z);
> 1/2*s4+2*p(t)+z;
> s8:=simplify(%);
> exp(int(%,t));
> expand(%);
> g:=(%);
> simplify(g,power);
> g:=%;
> Int(%,t);
> Integralg:=(%);
> int(g1(t),t);
> x1:=-p(t)+g1(t)/(%);
> diff(x1,t)+x1^2-s3;
> simplify(%);
> s10:=numer(%);
> solve(%,int(g1(t),t));
> Ing:=(%);
> simplify(subs(g1(t)=g,%));
>
```

```
>  Ing:=(%);
> expand(%);
> Ing:=simplify(%);
> simplify(diff(%,t)-g);
> expand(%);
> simplify(%);
> x:=-p(t)+g/Ing;
> simplify(diff(x,t)+x^2-s3);
>  int(x,t);
> exp(%);
> expand(%);
> s11:=simplify(%);
> ALT:=t*(2-t)*diff(u(t),t$2)+2*(1-t)*diff(u(t),t)+(2-m^2/(1-(1-t)^2))*u(t);
> -2*(1-t)/(2*t*(2-t));
> int(%,t);
> exp(%);
> s12:=simplify(%,power);
>
> u1:=s12*s11;
> u1:=simplify(%,power);
>  simplify(subs(u(t)=u1,ALT));
> AL:=(1-nu^2)*diff(u(nu),nu$2)-2*nu*diff(u(nu),nu)+(2-m^2/(1-nu^2))*u(nu);
>
> u2:=subs(t=1-nu,u1);
> simplify(subs(u(nu)=u2,AL));
>
```

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

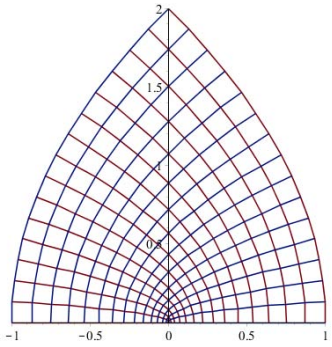
57 Understanding conformal mapping in maple

To plot mapping of complex function in maple, use `[plots]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..1+I` Because 0 is the lower left corner, and $(1, i)$ is the upper right corner. Example:

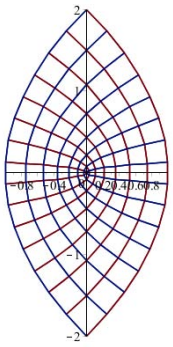
```
restart;
assume(y,real);
assume(x,real);
#f:= z->I+z*exp(I*Pi/4);
f:= z->z^2;
w:=f(x+I*y);
```

```
u:=Re(w);
v:=Im(w);
plots:-conformal(f(z),z=0..1+I,grid=[16,16],numxy=[16,16],scaling=constrained);
```



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

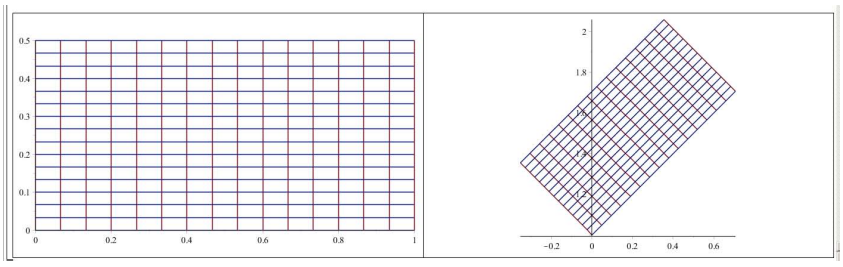
```
restart;
assume(y,real);
assume(x,real);
#f:= z->I+z*exp(I*Pi/4);
f:= z->z^2;
w:=f(x+I*y);
u:=Re(w);
v:=Im(w);
plots:-conformal(f(z),z=-1-I..1+I,grid=[16,16],numxy=[16,16],scaling=constrained
    );
```



This below puts the plots next to each others so to see them

```
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);
```



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

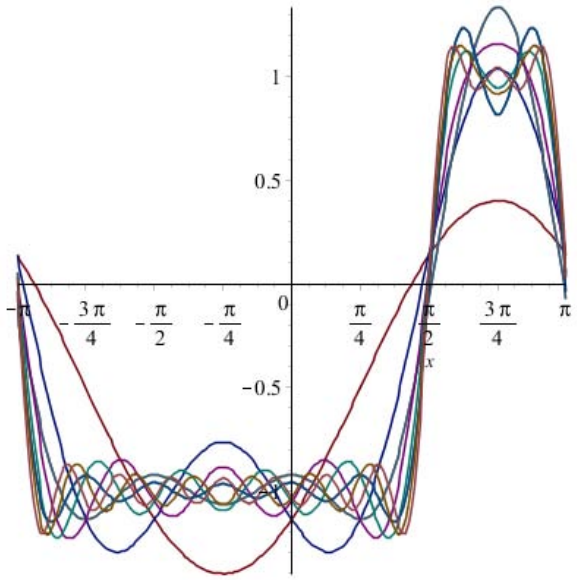
`interface(showassumed=0)` removes all tildas and `interface(showassumed=1)` adds the tildas.

59 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);
```



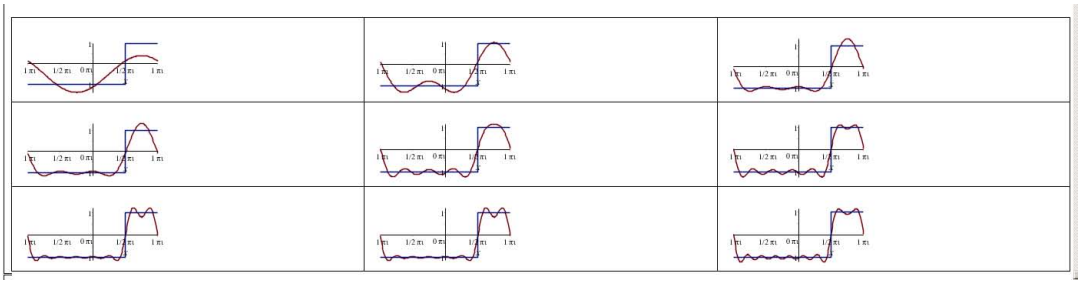
To animate do

```
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->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::integer)
       local n::integer,denomC,denomS,a,b;

       denomC:=( to_ - from_ ) / 2;
       denomS:=( to_ - from_ ) / 2;

       a:=proc(n)
```

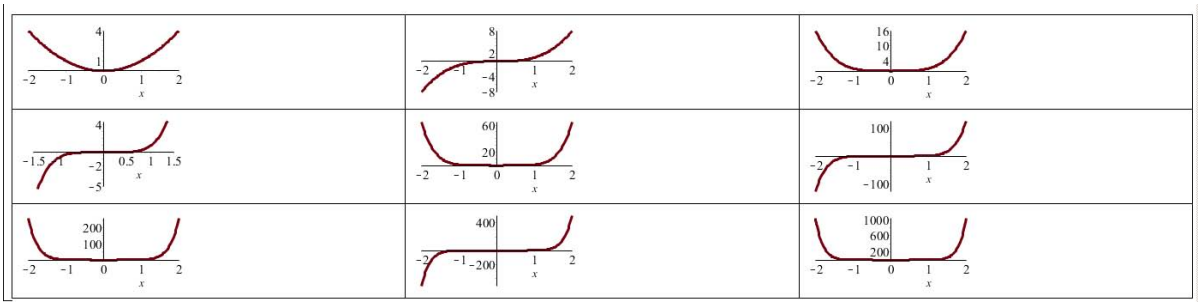
```
          int(f(x)*cos(n*freq*x),x=from_..to_) /denomC;
       end proc;

       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;

plots[setoptions](title=` `, axesfont=[SYMBOL,8] ,font=[COURIER,1],
   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"]);

B:=array(1..3,1..3);
k:=0;
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;

plots:-display( B);
```



60 How to plot graphs next to each others in a grid like fashion

```
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] );
```

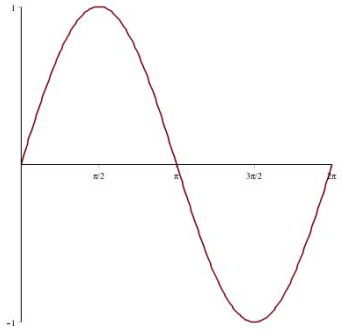
```
   end do;
end do;
plots:-display(B);
```



61 How to generate Pi on X-axis

From book Maple animation by John Putz

```
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=["",""] );
```



62 How to make output from FunctionAdvisor look better?

From Preben Alsholm

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

or answer by Thomas Richard

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

63 How to do partial fractions?

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

64 How to generate sequence sum symbolically

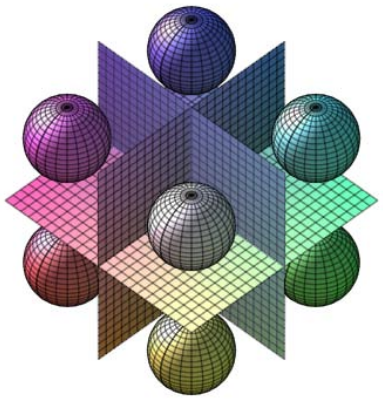
```
n := 7;
f:=sum('a[k]*b[k]','k'=1..n);
```

$$a_1b_1 + a_2b_2 + a_3b_3 + a_4b_4 + a_5b_5 + a_6b_6 + a_7b_7$$

65 Nice plot from Maple

from Serge from the net:

```
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]);
```



66 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));
```

67 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));
```

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

68 How to find what new additions made to Maple?

```
?updates,maple10
```

69 Maple can't solve laplace equation and numerically

Maple 2020.

```
restart;
PDE := diff(u(x,y), y$2 ) + diff(u(x,y), x$2) = 0;
BC:= u(x,0)=0, u(x,100)=100, u(0,y)=0, u(10,y)=0;
sol:=pdsolve(PDE,[BC] ,numeric);

Error, (in pdsolve/numeric) unable to handle elliptic PDEs
```

Compare to

```
restart;
PDE := diff(u(x,y), y$2 ) + diff(u(x,y), x$2) = 0;
BC:= u(x,0)=0, u(x,100)=100, u(0,y)=0, u(10,y)=0;
sol:=pdsolve([PDE,BC]);
```

$$u\left(x,y\right)=\sum_{n=1}^{\infty}-200\,\frac{\left(\left(-1\right)^{n}-1\right)\mathrm{e}^{10\,\pi\,n}\sin\left(1/10\,n\pi\,x\right)\left(\mathrm{e}^{1/10\,n\pi\,y}-\mathrm{e}^{-1/10\,n\pi\,y}\right)}{\pi\,n\left(\mathrm{e}^{20\,\pi\,n}-1\right)}$$

70 Some Maple Matrix operations

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

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

$$\begin{bmatrix}1 & 2 & 3\\ 4 & 5 & 6\end{bmatrix}$$

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

$$\begin{bmatrix}7 & 8 & 10\\ 11 & 12 & 13\\ 14 & 15 & 16\end{bmatrix}$$

Now append first row of A to last 2 rows of B

```
C:=<  A[1,1..-1] ,  B[2..-1,1..-1] >;
```

$$\begin{bmatrix} 1 & 2 & 3 \\ 11 & 12 & 13 \\ 14 & 15 & 16 \end{bmatrix}$$

```
# 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]  >;
```

$$\begin{bmatrix} 1 & 7 & 8 & 10 \\ 4 & 11 & 12 & 13 \end{bmatrix}$$

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

$$\begin{bmatrix} 7 & 8 & 10 \\ 14 & 15 & 16 \end{bmatrix}$$

```
#now set the diagonal elements of B to be 0
B:=RandomMatrix(3);
for i from 1 to 3 do
    B[i,i]:=0;
end do:
B;
```

$$B := \begin{bmatrix} 0 & 99 & 92 \\ 8 & 0 & -31 \\ 69 & 44 & 0 \end{bmatrix}$$

$$\begin{bmatrix} 0 & 99 & 92 \\ 8 & 0 & -31 \\ 69 & 44 & 0 \end{bmatrix}$$

To find inverse.

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

$$\begin{bmatrix} 1/2 & 0 \\ -1 & 1/2 \end{bmatrix}$$

To check that for any matrix A, then `A*transpose(A)` is always a matrix which is symmetrical

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

$$A := \begin{bmatrix} 99 & 44 & -31 \\ 29 & 92 & 67 \end{bmatrix}$$

$$\begin{bmatrix} 99 & 44 & -31 \\ 29 & 92 & 67 \end{bmatrix}$$

how to create a random lower triangular matrix?

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

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

71 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);
```

$$A := \begin{bmatrix} 1 & -98 & -76 & -4 & 29 \\ -38 & 1 & -72 & 27 & 44 \\ -18 & 57 & 1 & 8 & 92 \\ 87 & 27 & -32 & 1 & -31 \\ 33 & -93 & -74 & 99 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 & -98 & -76 & -4 & 29 \\ -38 & 1 & -72 & 27 & 44 \\ -18 & 57 & 1 & 8 & 92 \\ 87 & 27 & -32 & 1 & -31 \\ 33 & -93 & -74 & 99 & 1 \end{bmatrix}$$

72 How to multiply roots of a polynomial?

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

Gives

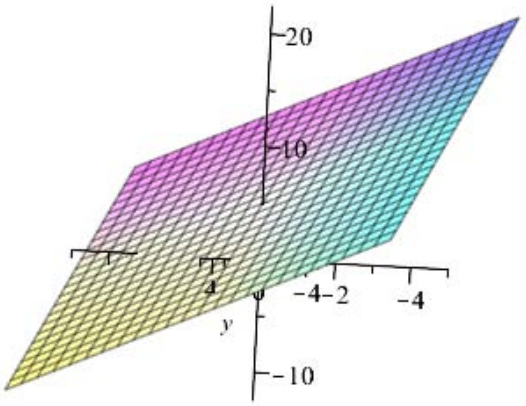
$$eq := 3x^3 + 2x^2 + x + 5 = 0$$

$$s := [-1.342780428,\ 0.3380568807 - 1.061566392\ I,\ 0.3380568807 + 1.061566392\ I]$$

$$-1.666666666 - 1.157693742\ 10^{-10}\ I$$

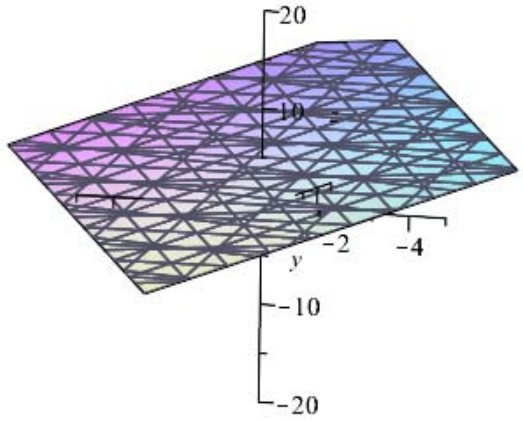
73 How to plot a surface in 3D?

```
restart;
eq:=3*x+4*y+2*z=10;
plot3d(solve(eq,z),x=-5..5,y=-5..5,axes=normal);
```



One can also use impliticplot3d

```
restart;
with(plots):
implicitplot3d(3*x+4*y+2*z=10, x=-5..5,y=-5..5, z=-20..20,axes=normal);
```



74 How to convert trigs to sinc function in an expression

From `http://www.mapleprimes.com/questions/40470-Trigonometric-Function-To-Sinc-Function`

Maple doesn't have a sinc function. If you mean the function $\mathrm{sinc}(x) = \sin(x)/x$, 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))});
```

75 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);
```

$$A := \begin{bmatrix} 1 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 1 & 0 \end{bmatrix}$$

$$\left\{ \begin{bmatrix} -1 \\ 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}, \begin{bmatrix} 0 \\ -1 \\ 0 \\ 1 \\ 0 \end{bmatrix}, \begin{bmatrix} -1 \\ 0 \\ 1 \\ 0 \\ 0 \end{bmatrix} \right\}$$

$$\left[\begin{bmatrix} 1 \\ 0 \end{bmatrix}, \begin{bmatrix} 0 \\ 1 \end{bmatrix} \right]$$

76 How to fix the interface to using Maple notation for input?

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

77 How to find all solutions using allvalues ?

```
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
```

78 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);
```

79 How to search help for updates on some package

Go to `http://www.maplesoft.com/support/help/search.aspx`

and type say `updates,Maple17,DE` in the small box there.

80 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.

81 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

82 Code editors for Maple

1. `http://www.mapleprimes.com/forum/codeeditormaple`
2. `http://www.mapleprimes.com/blog/joe-riel/emacs-mode-for-maple`
3. `http://www.mapleprimes.com/blog/jacquesc/vim-mode-for-maple`
4. `http://www.maplesoft.com/products/toolboxes/IDE/index.aspx`

83 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');
```

84 How to replace a string?

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

85 How to use geometry and plottools ?

```
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(c(2)),plottools:-circle(d(1)),geometry:-draw(o)
    );
```

To know more about the intersection, use this:

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

86 How to simplify log expressions ?

Use symbolic option

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

87 How to simplify hyperbolic expression ?

How to convert

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

to

$$3\coth^3(x)-\coth(x)$$

```
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));
```

88 How to create text file and append string to it?

```
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:
```

89 How to search packages and libraries?

To find in which library a command is do

```
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

```
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

```
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:

```
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


```
["crinterp", "equation", "`{}`", "even", "debugopts",
  "embedded_imaginary", "define_external", "embedded_real",
  "coeff", "cx_zero", "coeffs", "embedded_axis", "conjugate",
  "constant", "convert", "cx_infinity", "dlclose", "identical",
  "divide", "hfloat", "`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",
  "`evalf/hypergeom/kernel`", "atomic", "hfarray", "anything",
  "hastype", "complex", "has", "boolean", "goto", "`:-`",
  "gmp_isprime", "`!`", "genpoly", "anyfunc", "gc", "algebraic",
  "SFloatMantissa", "ssystem", "Scale10", "`stop`", "Scale2",
  "sort", "SearchText", "`[]`", "`~`", "`subset`", "~Array",
  "subsindets", "~Matrix", "streamcall", "~Vector", "subs",
  "Unordered", "table", "ToInert", "system",
  "_hackwareToPointer", "substring", "UpdateSource", "subsop",
  "_maplet", "trunc", "_jvm", "`kernel/transpose`", "_treeMatch",
  "tcoeff", "_savelib", "taylor", "abs", "rtable_num_dims",
  "addressof", "rtable_num_elems", "_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", "ArrayOptions", "order",
  "Array", "parse", "`**`", "overload", "`*`", "`::`", "numer",
  "CopySign", "numelems", "`^`", "`or`", "`||`", "op", "nops",
  "seq", "normal", "time", "`not`", "piecewise", "numboccur",
  "`?[]`", "userinfo", "modp2", "inner", "mods", "timelimit",
  "mvMultiply", "traperror", "negate", "rtable_normalize_index",
  "call_external", "rtable_is_zero", "assigned", "rtable_indfns",
  "evalf", "rtable_histogram", "eval", "evaln", "rtable_eval",
  "truefalse", "evalhf", "rtable_convolution", "tabular", "mul",
  "rtableInfo", "zppoly", "`if`", "rtable", "uneval", "remove",
  "sfloat", "rhs", "specfunc", "readlib", "string", "reduce_opr",
  "symbol", "ASSERT", "`?()`", "realcons", "TRACE", "`quit`",
  "relation", "_local", "pointto", "sequential", "add", "print",
  "set", "SFloatExponent", "iolib", "radical", "SDMPolynom",
  "`int/series`", "protected", "Record", "irem", "procedure",
  "Re", "iquo", "poszero", "isqrt", "real_infinity", "RETURN",
  "is_gmp", "ratpoly", "`+`", "lcoeff", "rational", "OrderedNE",
  "kernelopts", "range", "Object", "NumericEventHandler",
  "icontent", "numeric", "NumericStatus", "igcd", "odd",
  "NumericClass", "ilog10", "nonpositive", "NumericEvent",
```

”ilog2”, ”nonreal”, ”‘implies‘”, ”posint”, ”NameSpace”,
”indets”, ”positive”, ”NextAfter”, ”indices”, ”polynom”,
”MPFloat”, ”‘intersect‘”, ”pos_infinity”, ”MorrBrilCull”,
”‘<‘”, ”member”, ”neg_infinity”, ”Im”, ”maxnorm”, ”name”,
”‘<>‘”, ”max”, ”negint”, ”‘<=‘”, ”map2”, ”negative”, ”modp1”,
”nonnegative”, ”FromInert”, ”modp”, ”negzero”,
”EqualStructure”, ”‘minus‘”, ”nonposint”, ”‘>=‘”, ”min”,
”nonnegint”, ”‘>‘”, ”DefaultUnderflow”, ”lexorder”,
”imaginary”, ”‘=‘”, ”lhs”, ”indexable”, ”ERROR”, ”ldegree”,
”indexed”, ”EqualEntries”, ”length”, ”integer”, ”macro”,
”list”, ”DEBUG”, ”map”, ”literal”, ”‘..‘”, ”lowerbound”,
”‘module‘”, ”Default0”, ”lprint”, ”moduledefinition”,
”DefaultOverflow”]
296

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

This one has one solution

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

```
restart;
R := 0.4; px := 32000; Mm := 0.1; Ds := 9; DO2 := 7.2; YXS := 0.3; KS := 10;
Sp := 30; Cb := 8; KO2 := 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 := diff(x1(r),r$2) + 2/r*diff(x1(r),r)= Vo/DO2,
diff(x2(r),r$2) + 2/r* diff(x2(r),r)= Vs/Ds;
ic:=D(x1)(R0)=0,x1(R) = Cb,D(x2)(R0)= 0, x2(R) = Sp;
sol:=dsolve({eqs,ic},numeric,{x1(r),x2(r)},'abserr'=.52,'maxmesh'=1000,output=
   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);
```

91 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
```

92 How to display on screen for specific width?

This below by Axel Vogt 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);

3.1415926535897932384626433832795028841\
9716939937510582097494459230781640628620\
998628034825342117068
```

93 Maple IDE links

for VIM

1. `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

94 loading, remove and finding what packages loaded

use `packages();` to find what packages loaded. use `unwith` to remove package

```
packages();
                                  []

with(DynamicSystems):
packages();
                          [DynamicSystems]

unwith(DynamicSystems);
packages();
                                  []
```

95 some rules of thumbs when using Maple

1. put `restart` in separate execution group
2. do not use `with` inside proc(). Use `uses` instead.

96 How to write derivative

To write $y'(x) = x$, one way is `diff(y(x),x)=x` and another is `D(y)(x)=x`. To write $y''(x) = x$, one way is `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)`

97 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

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

Which gives

$$u(x,t) = \sum_{\_Z1=1}^{\infty} \_C1(\_Z1) \sin\left(\frac{\pi \_Z1\, x}{L}\right) \mathrm{e}^{-\frac{k\pi^2 \_Z1^2 t}{L^2}}$$

Which can be made more readable as follows

```
sol:=algsubs(_Z1=n,sol):
sol:=algsubs(Pi*n/L=lambda(n),sol);
```

$$u(x,t) = \sum_{n=1}^{\infty} \_C1(n) \sin(x\lambda(n)) \mathrm{e}^{-kt(\lambda(n))^2}$$

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

$$u(x,t) = \_C3\, \_C2 \left(\mathrm{e}^{1/4 \frac{2i\pi xL - k\pi^2 t}{L^2}} + \mathrm{e}^{-1/4 \frac{\pi(2ixL + k\pi t)}{L^2}}\right)$$

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

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

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);
```

$$u(x,t) = \sum_{n=1}^{\infty} 768 \frac{1}{\pi \left(16n^4 + 32n^3 - 136n^2 - 152n + 105 \right)} e^{-1/4 \frac{k\pi^2 t(1+2n)^2}{L^2}} \cos\left(1/2 \frac{\pi x (1+2n)}{L} \right)$$

Another example

```
restart;
pde:=diff(u(x,t),t)=k*diff(u(x,t),x$2);
bc:=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;
```

$$u(x,t) = \sin\left(\frac{\pi x}{L} \right) e^{-9 \frac{\pi^2 kt}{L^2}} \left(-2 \cos\left(2 \frac{\pi x}{L} \right) + 3 e^{8 \frac{\pi^2 kt}{L^2}} - 1 \right)$$

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

98 How to make multiple assumptions on a symbol?

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

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

99 How to make Maple display diff(y(x),x) as $y'(x)$ or as y' ?

Add this

```
expr:=diff(y(x),x);
Typesetting:-Settings(typesetprime=true, prime=x):
```

The above will display the expression as $y'(x)$. To make it now show the x do

```
expr:=diff(y(x),x);
Typesetting:-Settings(typesetprime=true, prime=x):
Typesetting:-Suppress(y(x));
```

Now it will show the expression as just y'. For all the above to work, make sure you have `Typesetting level` set to `Extended` in the GUI.

This is done inside `Tools->Options->Display` menu.

To clear all the above `Typesetting`, do `restart` or do `Typesetting:-Unsuppress(y(x))`

100 How to check if expression is an equation?

check for '=' as follows

```
eq:= x=1;
whattype(eq);   #  `=`

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

      "yes"
```

101 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"
```

102 How to set boundary conditions for dsolve or pdsolve?

The Maple syntax for seeting 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

Conditions	Maple code
$u(0,t)=0$	`u(0,t)=0`
$\frac{\partial u}{\partial x}=0$ at $x=0$	`D[1](u)(0,t)=0`
$\frac{\partial^2 u}{\partial x^2}=0$ at $x=0$	`D[1,1](u)(0,t)=0`
$\frac{\partial^3 u}{\partial x^3}=0$ at $x=0$	`D[1,1,1](u)(0,t)=0`
$\frac{\partial u}{\partial t}=0$ at $t=0$	`D[2](u)(x,0)=0`
$\frac{\partial^2 u}{\partial t^2}=0$ at $t=0$	`D[2,2](u)(x,0)=0`
$\frac{\partial^3 u}{\partial t^3}=0$ at $t=0$	`D[2,2,2](u)(x,0)=0`

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

Conditions	Maple code
$y(0) = 0$	`y(0)=0`
$\frac{dy}{dx} = 0$ at $x = 0$	`D(y)(0)=0`
$\frac{d^2y}{dx^2} = 0$ at $x = 0$	`(D@@2)(y)(0)=0`

103 How to export a plot to PDF?

I could only find a way to export to eps

```
plotsetup(default):
plotsetup(postscript, plotoutput=`t.eps`, plotoptions=`color,portrait,height
    =300`);
plot(sin(x),x=-Pi..Pi,'gridlines');
plotsetup(default):
```

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

```
plotsetup(postscript, plotoutput=`t0.eps`, plotoptions=`color,portrait,height
    =300`);
ode:= diff(y(x),x) = 3*x^2 - 1;
DEtools:-DEplot( ode, y(x), x=-2..2, [y(0) = 0], y=-2..2,
              linecolour=red, color = blue, stepsize=.05,arrows=MEDIUM );
plotsetup(default);
```

104 How to find all roots of complex number

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

```
fsolve(z^3=(3+4*I),z);

#gives

-1.26495290635775+1.15061369838445*I,
-.363984239564424-1.67078820068900*I,
1.62893714592218+.520174502304545*I
```

105 How to convert matrix of matrices to a matrix?

```
A:= Matrix(2, 2, {(1, 1) = 0, (1, 2) = 0, (2, 1) = 0, (2, 2) = 2});
f:=x->`if`(x<>0,x*LinearAlgebra:-IdentityMatrix(2),0*Matrix(2));
B:=map(f,A);
```

Which gives

$$\begin{bmatrix} \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} & \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} \\ \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} & \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix} \end{bmatrix}$$

now

```
r:=Matrix(convert(B,listlist))
```

Gives

$$\begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 2 \end{bmatrix}$$

106 How to do pattern matching in Maple?

Maple has a simple but easy to use pattern matching, which works well. Here are some example. For each case, will show what pattern to detect and how to do it. I am still not very good at pattern matching in Maple and will need to make improvement in this with time.

106.1 Example 1

Detect $\sqrt{(}xy)$ in expression.

```
restart;
expr:= sin(x)*sqrt(x*y);
if patmatch(expr,a::anything*(b::anything*x*y)^(c::anything),'la') then
    assign(la);
    if c =1/2 or c=-1/2 then
       print("found sqrt(x*y)");
    else
       print("did not find sqrt(x*y)");
    fi;
 fi;
```

But if the expression was $\sin(x)\sqrt{xy}+3$ then the above would fail, because there are a term after $\sqrt{xy}$, so the pattern has to change to

```
restart;
expr:= sin(x)*sqrt(x*y)+3;
if patmatch(expr,a::anything*(b::anything*x*y)^(c::anything)+d::anything,'la')
   then
    assign(la);
    if c =1/2 or c=-1/2 then
       print("found sqrt(x*y)");
    else
       print("did not find sqrt(x*y)");
    fi;
 fi;
```

107 How to find trig indetities?

use `trigsubs`, very useful command. For example

```
trigsubs(cos(theta)^3)
```

Gives

$$[1/2\ \cos(\theta) + 1/2\ \cos(2\,\theta)\cos(\theta), 1/4\ \cos(3\,\theta) + 3/4\ \cos(\theta)]$$

108 How to find directional derivative of scalar function?

Given $f(x,y,z) = x^2z + y^3z^2 - xyz$ we want to find its directional derivative along the vector n.

One way

```
n:=<-1,0,3>;
g:=VectorCalculus[Gradient](x^2*z+y^3*z^2-x*y*z, [x,y,z]);
Student[VectorCalculus][DotProduct](g,n/LinearAlgebra[Norm](n,2))
```

Gives

$$-\frac{\left(2\,xz - yz\right)\sqrt{10}}{10} + \frac{\left(6\,y^3z + 3\,x^2 - 3\,xy\right)\sqrt{10}}{10}$$

Another is

```
Student[MultivariateCalculus][DirectionalDerivative](x^2*z+y^3*z^2-x*y*z, [x,y,z
   ], [-1,0,3]);
```

Gives the same result.

109 How to check if name is assigned a value?

For simple variable, use `assigned`

```
restart;
x:=10:
assigned(x)
                              true
assigned(y)
                             false
```

For a field in table do

```
restart;
A:=table(["x"=10,"y"=20]):

assigned(A["x"])
                                true
assigned(A["z"])
                               false
```

For field in Record, I do not know how yet, other than using try catch, as assigned does not seem to work for Record fields.

```
restart;
A:=Record('x'=10,'y'=20);
try
   assigned(A:-x)
catch:
   print("no such field in record")
end try;

                                true

try
   assigned(A:-z)
catch:
   print("no such field in record")
end try;

                   "no such field in record"
```

110 How to use dsolve with Lie?

Use `dsolve(ode,Lie)`

To find symmetries, do

`DEtools:-symgen(ode,y(x),HINT=[c__1+c__2*x+c__3*y,c__4+c__5*x+c__6*y])`

or just

`DEtools:-symgen(ode,y(x))`

To debug it do

`stopat(`ODEtools/symgen`);` before calling `dsolve` or `DEtools:-symgen`

111 How to select terms with sqrt or radical in them from an expression

Given

$$3 + x + \sqrt{-4ac + b^2} + \sin(y) + x^3\sqrt{39} + \sqrt{\cos x}$$

Find terms that are sqrt. Use `indets`

```
restart;
expr_with_radical:= 3+x+sqrt(b^2-4*a*c)+sin(y)+x^3*sqrt(39)+sqrt(cos(x));|
indets(expr_with_radical, algebraic^fraction)
```

$$\{\sqrt{39}, \sqrt{-4ac + b^2}, \sqrt{\cos x}\}$$

Alternative is to use type `radical`

```
restart;
expr_with_radical:= 3+x+sqrt(b^2-4*a*c)+sin(y)+x^3*sqrt(39)+sqrt(cos(x));|
indets(expr_with_radical, radical)
```

$$\{\sqrt{39}, \sqrt{-4ac + b^2}, \sqrt{\cos x}\}$$

112 How to simplify $e^{\ln(x)+\ln(y)}$

given

$$e^{\frac{2\ln\left(\sqrt{p^2+1}+p\right)+2\ln(a)+\ln\left(p^2+1\right)a}{2a}} + e^{3x}$$

`simplify(expr)` does not work. So tried `subsindets`

```
restart;
expr := exp((2*ln(sqrt(p^2 + 1) + p) + 2*ln(a) + ln(p^2 + 1)*a)/(2*a))+ exp(3*x)
   ;
subsindets(expr,'specfunc( anything, exp )',f->(`if`(has(op(1,f),'ln'),expand(f),
   f)))
```

$$\left(\sqrt{p^2+1} + p\right)^{\frac{1}{a}} a^{\frac{1}{a}} \sqrt{p^2+1} + e^{3x}$$

It is possible to also try `simplify(expr,exp)` in some cases, but for the above example, this did not work, i.e. it did not simplify it.

113 How to find all csgn() and replace them by 1

I wanted to simplify an expression which could have `csgn()` in it, and find all the arguments.

$$\frac{1+\text{csgn}(a)a}{3\text{csgn}(b)b}$$

One way is

```
restart;
expr:=(1+csgn(a)*a)/(3*csgn(b)*b):
fun:=selectfun(expr,'csgn'); #find csgn if any

if numelems(fun)>0 then
    the_args:= op~(1,fun);
    simplify(expr) assuming map(x->x::positive,the_args)[];
fi;
```

$$\frac{1+a}{3b}$$

114 How to replace all abs(expr) by expr

I wanted to replace `|expr|` by `(expr)`

One way is

```
restart;
expr:=u(x) = _C1*exp(-3*x^(1/3)*sqrt(c))*(3*x^(1/3)*sqrt(c) + 1) + _C2*exp(3*x
    ^(1/3)*sqrt(c))*abs(-1 + 3*x^(1/3)*sqrt(c));
expr:=subsindets(sol,'specfunc( anything, abs )',f->(f assuming op(1,f)>0));

#gives
 _C1*exp(-3*x^(1/3)*sqrt(c))*(3*x^(1/3)*sqrt(c) + 1) + _C2*exp(3*x^(1/3)*sqrt(c)
    )*(-1 + 3*x^(1/3)*sqrt(c))
```

115 How to find basis for Null space, Row space and column space of matrix?

Given

$$\begin{bmatrix} 1 & -1 & 0 & 2 \\ 1 & 2 & 2 & -2 \\ 0 & 2 & 3 & -1 \end{bmatrix}$$

Find its Null, Row and Column space basis vectors.

```
restart;
A:=Matrix([[1,-1,0,2],[1,2,2,-2],[0,2,3,-1]]);
LinearAlgebra:-NullSpace(A)
```

$$\left\{\begin{bmatrix} 0 \\ 2 \\ -1 \\ 1 \end{bmatrix}\right\}$$

```
restart;
A:=Matrix([[1,-1,0,2],[1,2,2,-2],[0,2,3,-1]]);
LinearAlgebra:-RowSpace(A)
```

$$\left[\begin{bmatrix} 1 & 0 & 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 & 0 & -2 \end{bmatrix}, \begin{bmatrix} 0 & 0 & 1 & 1 \end{bmatrix}\right]$$

```
restart;
A:=Matrix([[1,-1,0,2],[1,2,2,-2],[0,2,3,-1]]);
LinearAlgebra:-ColumnSpace(A)
```

$$\left[\begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}, \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}\right]$$

116 How to do Gaussian elimination on a Matrix?

Given

$$\begin{bmatrix} 1 & -4 & -3 & -7 \\ 2 & -1 & 1 & 7 \\ 1 & 2 & 3 & 11 \end{bmatrix}$$

Find the new form after Gaussian elimination

```
restart;
A:=Matrix([[1,-4,-3,-7],[2,-1,1,7],[1,2,3,11]]);
LinearAlgebra:-GaussianElimination(A);
```

$$\begin{bmatrix} 1 & -4 & -3 & -7 \\ 2 & -1 & 1 & 7 \\ 1 & 2 & 3 & 11 \end{bmatrix}$$

117 How to find Reduced Echelon form of a Matrix?

Given matrix

$$\begin{bmatrix} 5 & 2 & 18 \\ 0 & 1 & 4 \\ 4 & 1 & 12 \end{bmatrix}$$

Find its Reduced Echelon form.

```
restart;
A:=Matrix([[5,2,18],[0,1,4],[4,1,12]]);
Student:-LinearAlgebra:-ReducedRowEchelonForm(A)
```

$$\begin{bmatrix} 1 & 0 & 2 \\ 0 & 1 & 4 \\ 0 & 0 & 0 \end{bmatrix}$$

Another option is

```
restart;
A:=Matrix([[5,2,18],[0,1,4],[4,1,12]]);
MTM:-rref(A)
```

$$\begin{bmatrix} 1 & 0 & 2 \\ 0 & 1 & 4 \\ 0 & 0 & 0 \end{bmatrix}$$

118 How add a new row to bottom of matrix?

Given matrix

$$\begin{bmatrix} 1 & 1 \\ 2 & 3 \\ 4 & 5 \end{bmatrix}$$

How to add row

$$[a, b]$$

to end of the matrix?

```
restart;
A:=Matrix([[1,1],[2,3],[4,5]]);
the_row:=convert([a,b],Vector['row']);
ArrayTools:-Concatenate(1,A,the_row);
```

$$\begin{bmatrix} 1 & 1 \\ 2 & 3 \\ 4 & 5 \\ a & b \end{bmatrix}$$

119 How to obtain list of all occurances of some function in an expression?

For an example, How to find list of all ln functions in this expression?

$$\ln(|x+1|) + 2x\ln(x) + \sin(x)$$

```
restart;
expr:=ln(abs(x+1))+2*x*ln(x)+sin(x);
tmp := indets(expr,'specfunc(anything,ln)');

          #   tmp := {ln(x), ln(abs(x + 1))}
```

To pick only ln functions which has *abs* inside them anywhere, replace the above with

```
restart;
expr:=ln(abs(x+1))+2*x*ln(x)+sin(x);
lis:=indets(expr,'specfunc(anything,ln)');
select(Z->has(Z,abs),lis)

          #   tmp := {ln(abs(x + 1))}
```

Or, better alternative to the above is

```
restart;
expr:=ln(abs(x+1))+2*x*ln(x)+sin(x);
indets(expr,'specfunc( satisfies(u->has(u,abs)) ,ln  )');

          #   tmp := {ln(abs(x + 1))}
```

120 How to replace $\ln(|x|)$ with $\ln(x)$ in an expression?

Given

$$\sin(x) + \ln(|x|) + \ln\left(x + \frac{|y|}{\sqrt{|x+3|}}\right) + \ln\left(x^3\right) + \cos(|x|)$$

How to remove the absolute, the ones only inside each ln in the above expression?

```
restart;
expr:=sin(x)+ln(abs(x))+ln(x+abs(y)/sqrt(abs(x+3)))+ln(x^3)+cos(abs(x));
expr:=evalindets(expr,'specfunc(ln)',f->evalindets(f,'specfunc(abs)',f->op(1,f))
   )

#   sin(x) + ln(x) + ln(x + y/sqrt(x + 3)) + ln(x^3) + cos(abs(x))
```

$$\sin(x) + \ln(x) + \ln\left(x + \frac{y}{\sqrt{x+3}}\right) + \ln\left(x^3\right) + \cos(|x|)$$

121 How to find all signum functions in expression and simplify it?

Given

$$-\frac{\left(\ln\left(\frac{\left(b+\sqrt{b^2+y(x)^2}\ \text{signum}(b)\right)b}{y(x)}\right)+\ln(2)\right)\text{signum}(b)}{b}=\_C1+\frac{-\ln(a)+\ln(x)-\ln\left(a+\sqrt{a^2+x^2}\ \text{signum}(a)\right)-\ln(2)}{|a|}$$

How to find all arguments of `signum` and simplify the above by assuming they are all positive?

```
restart;
expr:=-(ln((b + sqrt(b^2 + y(x)^2)*signum(b))*b/y(x)) + ln(2))*signum(b)/b = _C1
    + (-ln(a) + ln(x) - ln(a + sqrt(a^2 + x^2)*signum(a)) - ln(2))/abs(a);
lis:=indets(expr,'specfunc(anything,signum)');
assum:=convert(map(x->op(1,x)>0,lis),list);
simplify(expr,assume=assum);
```

$$\frac{-\ln(b)-\ln\left(\frac{b+\sqrt{b^2+y(x)^2}}{y(x)}\right)-\ln(2)}{b}=\frac{\_C1a-\ln(a)-\ln\left(a+\sqrt{a^2+x^2}\right)+\ln(x)-\ln(2)}{a}$$

122 How to do change of variables on the dependent variable for an ODE?

given an ode

$$y(x)=\left(\frac{d}{dx}y(x)\right)^3 y(x)^2+2x\left(\frac{d}{dx}y(x)\right)$$

do change of variable $u(x)=y(x)^2$

```
restart;
ode:=y(x)=diff(y(x),x)^3*y(x)^2+2*x*diff(y(x),x);
new_ode:=PDEtools:-dchange({y(x)=sqrt(u(x))},ode,{u});
```

$$\sqrt{u(x)}=\frac{\left(\frac{d}{dx}u(x)\right)^3}{8\sqrt{u(x)}}+\frac{x\left(\frac{d}{dx}u(x)\right)}{\sqrt{u(x)}}$$

123 How to find the cofactor matrix of a matrix?

Use `LinearAlgebra:-Adjoint` and then transpose the result. Since the Adjoint is the transpose of the cofactor.

Given

$$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 10 \end{bmatrix}$$

then

```
restart;
A:=Matrix([[1,2,3],[4,5,6],[7,8,10]]);
LinearAlgebra:-Transpose(LinearAlgebra:-Adjoint(A))
```

$$\begin{bmatrix} 2 & 2 & -3 \\ 4 & -11 & 6 \\ -3 & 6 & -3 \end{bmatrix}$$

124 How to make phase plot of second order ODE?

Make a phase plot of

$$\frac{d^2}{dt^2}x(t) + \frac{\frac{d}{dt}x(t)}{2} + x(t) = u(t)$$

By plotting $x(t)$ vs $x'(t)$ without solving the ODE.

```
restart;
alias(DS=DynamicSystems):
ode := diff(x(t),t$2) +1/2*diff(x(t),t)+ x(t) = u(t);
sys:=DS:-DiffEquation(ode,'outputvariable'=[x(t)],'inputvariable'=[u(t)]);
sys0:=DS:-StateSpace(sys);
eq1:=diff(x1(t),t)=sys0:-a[1,..].Vector([x1(t),x2(t)]);
eq2:=diff(x2(t),t)=sys0:-a[2,..].Vector([x1(t),x2(t)]);
DEtools:-DEplot([eq1,eq2],[x1(t),x2(t)],t=0..35,[[x1(0)=1,x2(0)=1]],x1=-2..2,x2
   =-2..2,
        numpoints=200, linecolor=black, axes=boxed);
```

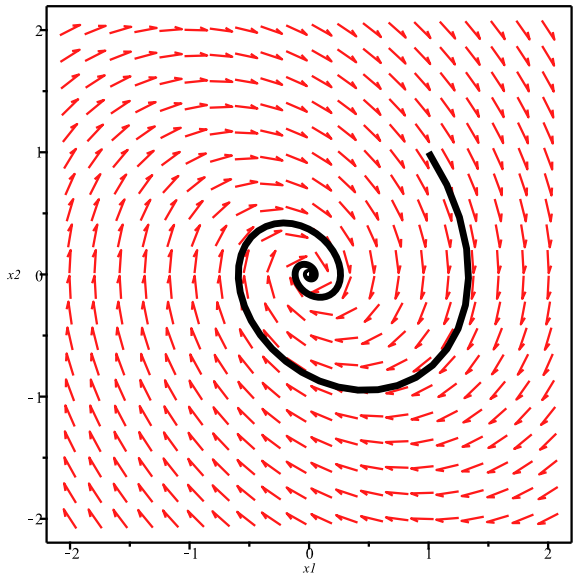


Figure 1: Phase Plot

125 How to normalize eigenvectors?

When finding eigenvectors of matrix, using `LinearAlgebra`, the vectors are not normalized. How to normalized them so the length is one?

One way is

```
restart;
LA:=LinearAlgebra;
Sx:=Matrix([[0,1,0],[1,0,1],[0,1,0]]);

#this finds eigenvectors in v
lam,v:=LA:-Eigenvectors(Sx);

#this normalize it
B:=map(n -> v[.., n]/norm(v[.., n], 2), [$1..LA:-RowDimension(v)]):
B:=`<|>`(op(B)); #this converts the list back to matrix.
```

$$v = \begin{bmatrix} -1 & 1 & 1 \\ 0 & \sqrt{2} & -\sqrt{2} \\ 1 & 1 & 1 \end{bmatrix}$$

$$B = \begin{bmatrix} -\frac{\sqrt{2}}{2} & \frac{1}{2} & \frac{1}{2} \\ 0 & \frac{\sqrt{2}}{2} & -\frac{\sqrt{2}}{2} \\ \frac{\sqrt{2}}{2} & \frac{1}{2} & \frac{1}{2} \end{bmatrix}$$

126 How to find if some function is present in an expression

Given expression $3\sin(x) + t + 3f(x,t)\,t + g(x,t)$ find if it contains function $f()$.

Use `indets` with `specfunc(f)`

```
restart;
expr := 3*sin(x)+t+3*f(x,t)*t+g(x,t);
res  := indets(expr, specfunc(f));
if numelems(res)<>0 then
   print("Found f(x,t)");
else
   print("could not find f(x,t)");
fi;
```

```
"Found f(x,t)"
```

127 How to find all functions in an expression?

Given expression $3\sin(x) + t + 3f(x,t)\,t + g(x,t)$ find all functions, if any, in the expression.

Use `indets` with `function`

```
restart;
expr := 3*sin(x)+t+3*f(x,t)*t+g(x,t);
res  := indets(expr,function);
if numelems(res)<>0 then
   print("Found these functions",res);
else
   print("could not find any function)");
fi;
```

```
"Found these functions", {f(x, t), g(x, t), sin(x)}
```

128 How to find all functions in an expression but exclude all build in math functions?

Given expression $3\sin(x)+t+3f(x,t)\,t+g(x,t)$ find all functions, if any, in the expression but exclude the math functions such as sin in the above.

```
restart;
expr := 3*sin(x)+t+3*f(x,t)*t+g(x,t);
res  := indets(expr, And( function, Not(typefunc(mathfunc))));
if numelems(res)<>0 then
   print("Found these functions",res);
else
   print("could not find any function)");
fi;
```

```
   "Found these functions", {f(x, t), g(x, t)}
```

129 How to obtain a list of all arguments of function?

use op

```
restart;
op(1..,f(x,t))

    x, t
```

Note that `op(0,f(x,t))` finds the function name.

130 How to obtain a list of all functions in expression whose first argument is z?

```
restart;
expr := 3*sin(z)+t+3*f(z,t,y)*t+g(x,t);
res  := indets(expr, patfunc(identical(z), anything));
if numelems(res)<>0 then
   print("Found these functions",res);
else
   print("could not find any function)");
fi;
```

gives

```
"Found these functions", {f(z, t, y), sin(z)}
```

131 How to obtain a list of all functions in expression whose second argument is t?

```
expr := 3*sin(z)+t+3*f(z,t,y)*t+g(x,t);
res  := indets(expr, patfunc(anything, identical(t), anything));
if numelems(res)<>0 then
   print("Found these functions",res);
else
   print("could not find any function)");
fi;
```

gives

```
"Found these functions", {f(z, t, y), g(x, t)}
```

132 How to typeset $\hbar$?

```
expr:=`&hbar;`*x
```

gives

$$\hbar x$$

Notice, the ; is needed. This `&hbar`*x will not work. It must be `&hbar;`*x

133 How to find the Curl of a vector?

First example

```
restart;
VectorCalculus:-SetCoordinates( 'cartesian'[x,y,z] );
F:=VectorCalculus:-VectorField(<y,-x,0>);
```

$$F = y\bar{\mathbf{e}}_{\mathbf{x}} - x\bar{\mathbf{e}}_{\mathbf{y}}$$

And now

```
VectorCalculus:-Curl(F);
```

$$-2\bar{\mathbf{e}}_{\mathbf{z}}$$

Second example

```
restart;
VectorCalculus:-SetCoordinates( 'cartesian'[x,y,z] );
F:=VectorCalculus:-VectorField(<y*z^2,x*z^2+2,2*x*y*z-1>);
```

$$F = y z^2 \bar{\mathbf{e}}_\mathbf{x} + (x z^2 + 2)\bar{\mathbf{e}}_\mathbf{y} + (2xyz - 1)\bar{\mathbf{e}}_\mathbf{z}$$

And now

```
VectorCalculus:-Curl(F);
```

$$0$$

Since Curl is zero, field is conservative.

Third example, in cylinderical coodinates

```
restart;
VectorCalculus:-SetCoordinates( 'cylindrical'[rho,phi,z] );
F:=VectorCalculus:-VectorField(<0,-rho,2>);
```

$$F = -\rho\bar{\mathbf{e}} + 2\bar{\mathbf{e}}_\mathbf{z}$$

And now

```
VectorCalculus:-Curl(F);
```

$$2\bar{\mathbf{e}}_\mathbf{z}$$

134 How to see all steps in finding RREF form of an augmented matrix?

Use `Student:-LinearAlgebra:-GaussJordanEliminationTutor( A, output=steps )` Where A is your augmented matrix.

135 How to find column space of matrix?

Do not use the Maple command `LinearAlgebra:-ColumnSpace` for this. it gives the columns in the RREF. The correct way is to obtain the corresponding columns of the pivot columns in the original matrix A. Hence use the command `Basis` like this

```
A:=Matrix([[1,0,0],[1,1,1]]);
LinearAlgebra:-Basis([seq(A[..,i],i=1..LinearAlgebra:-ColumnDimension(A) )]);
```

Which gives

$$\left[\begin{bmatrix} 1 \\ 1 \end{bmatrix}, \begin{bmatrix} 0 \\ 1 \end{bmatrix}\right]$$

If you use `ColumnSpace` command you'll get this

```
A:=Matrix([[1,0,0],[1,1,1]]);
LinearAlgebra:-ColumnSpace(A);
```

$$\left[\left[\begin{array}{c} 1 \\ 0 \end{array}\right], \left[\begin{array}{c} 0 \\ 1 \end{array}\right]\right]$$

These are different. `Basis` is the correct command to use, which matches the standard definition in textbooks.

136 How to use select with own type to find subexpressions?

Given expression such as $3 + (1 + x)\sin x$ or $3 + (1 + x)\sin^2 x$ use select to find any `polynomial * sin^n` subexpressions.

```
restart;
mytype_1 := ''`*`'( {polynom(And(algebraic, satisfies(u -> not has(u, I))),x),
                     Or( 'specfunc(sin)'^integer, 'specfunc(sin)')
                    }
                  )';
select(type, 3+(1+x)*sin(x),mytype_1);
select(type, 3+(1+x)*sin(x)^2,mytype_1);
```

Gives

```
                         (1 + x) sin(x)

                                       2
                        (1 + x) sin(x)
```

137 How to write structured types to match some expressions?

137.1 type for $\sin^m(x)\cos^n(x)$

```
restart;
my_type:=''`*`'( { Or('specfunc'(sin),'specfunc'(sin)^Or(integer,rational)),
                   Or('specfunc'(cos),'specfunc'(cos)^Or(integer,rational))})';

type(sin(x)^2*cos(x)^3,my_type);
type(sin(x)^2*cos(x),my_type);
type(sin(x)*cos(x),my_type);
```

```
type(cos(x)*sin(x)^(1/2),my_type);


           true
           true
           true
           true
```

I could not find a way to avoid writing `Or('specfunc'(sin),'specfunc'(sin)^Or(integer,rational` in order to match both $\sin x$ and $\sin^2 x$. For these things, I find Mathematica patterns more flexiable. The above can be done as follows in Mathematica

```
ClearAll[x,n,m,any]
patt=any_.*Sin[_]^n_. * Cos[_]^m_.
MatchQ[Sin[x]^2*Cos[2*x]^3,patt]
MatchQ[Sin[x]^2*Cos[x],patt]
MatchQ[Sin[x]*Cos[x],patt]
MatchQ[Cos[x]*Sin[x],patt]

      True
      True
      True
      True
```

In Mathematica `n_.` says basically to match $\sin x$ or $\sin^2 x$ since the dot says to match zero or more. So no need to duplicate things as I did above in Maple. There might be a way to do the same in Maple using structured type, but I could not find it. In General, I find patterns in Mathematica more flexible and easier to use for this sort of thing. Maple has `patmatch` command, but not as easy to use as Patterns in Mathematica.

138 How to use new object method calling in Maple 2021?

In Maple 2021, it is now possible to use `object:-method(arg)` notation. This makes is easier to use OOP in maple. To do this, use `_self` as follows

```
restart;

person:=module()
 option object;
 local name::string:="";
 local age::integer:=0;

 export get_name:=proc(_self,$)
   return _self:-name;
 end proc;
```

```
 export set_name:=proc(_self,name::string,$)
   _self:-name:=name;
 end proc;

 export get_age:=proc(_self,$)
   return _self:-age;
 end proc;

 export set_age:=proc(_self,age::integer,$)
   _self:-age:=age;
 end proc;

end module;
```

And now make an object and use it as follows

```
o:=Object(person)
                  o := Object<<1846759887808>>

o:-get_name();
              ""

o:-get_age();
              0

o:-set_name("joe doe");
o:-get_name();
           "joe doe"
```

139 How to make a constructor for an Object?

Add `ModuleCopy` proc in the class. This will automatically be called to initialize the object.

Here is an example

```
restart;

ODE:=module()
 option object;
 local ode:=NULL;
 local y::symbol;
 local x::symbol;
 local sol;

 export ModuleCopy::static := proc( _self::ODE, proto::ODE, ode, func, $ )
    print("Initilizing object with with args: ", [args]);
    _self:-ode:= ode;
```

```
    _self:-y:=op(0,func);
    _self:-x:=op(1,func);
 end proc;

 export dsolve::static:=proc(_self,$)
   _self:-sol := :-dsolve(ode,y(x));
 end proc;

 export get_sol::static:=proc(_self,$)
   return sol;
 end proc;

end module;
```

And now make an object and use it as follows

```
o:=Object(ODE, diff(y(x),x)+y(x)=sin(x), y(x));
o:-dsolve():
o:-get_sol();

        #y(x) = -1/2*cos(x) + 1/2*sin(x) + exp(-x)*_C1
```

So a constructor just makes it easier to initialize the object without having to make a number of `set()` calls to initialize each memeber data.

140 How to make different constructors for an Object?

This is done using `overload` with different `ModuleCopy` proc in the class.

Here is an example. Lets make a constructor that takes an ode and initial conditions, and one that only takes an ode with no initial conditions.

```
restart;

ODE:=module()
 option object;
 local ode:=NULL;
 local y::symbol;
 local x::symbol;
 local ic:=NULL;
 local sol;

 export ModuleCopy::static:= overload(
    [
       proc( _self::ODE, proto::ODE, ode, func, $ ) option overload;
          _self:-ode:= ode;
          _self:-y:=op(0,func);
```

```
          _self:-x:=op(1,func);
       end proc,

       proc( _self::ODE, proto::ODE, ode, func, ic, $ ) option overload;
          _self:-ode:= ode;
          _self:-y:=op(0,func);
          _self:-x:=op(1,func);
          _self:-ic :=ic;
       end proc
    ]
 );

 export dsolve::static:=proc(_self,$)
    if evalb(ic=NULL) then
       sol := :-dsolve(ode,y(x));
    else
       sol := :-dsolve([ode,ic],y(x));
    fi;
 end proc;

 export get_sol::static:=proc(_self,$)
   return sol;
 end proc;

end module;
```

And now use it as follows

```
o:=Object(ODE, diff(y(x),x)+y(x)=sin(x), y(x), y(0)=0);
o:-dsolve():
o:-get_sol();

         #y(x) = -1/2*cos(x) + 1/2*sin(x) + 1/2*exp(-x)

o:=Object(ODE, diff(y(x),x)+y(x)=sin(x), y(x));
o:-dsolve():
o:-get_sol();

    #y(x) = -1/2*cos(x) + 1/2*sin(x) + exp(-x)*_C1
```

141 How to do OOP inheritance?

In the child class you want to extend from the parent class, add `option object(ParentName);`

Here is an example

```
restart;
module ODE()
   option object;
   local ode;

   export set_ode::static:=proc(_self,ode,$)
     _self:-ode :=ode;
   end proc;

  export get_ode::static:=proc(_self,$)
     return _self:-ode;
   end proc;
end module;

#create class/module which extends the above
module second_order_ode()
   option object(ODE);
   export get_ode_order::static:=proc(_self,$)
      return 2;
   end proc;
end module;
```

In the above `second_order_ode` inherts all local variables and functions in the `ODE` class and adds new proc. Use as follows

```
o:=Object(second_order_ode); #create an object  instance
o:-set_ode(diff(y(x),x)=sin(x));
o:-get_ode();
o:-get_ode_order();
```

Note that the child class can not have its own variable with the same name as the parent class. This is limitation. in `C++` for example, local variables in extended class overrides the same named variable in the parent class.

Even if the variable have different type, Maple will not allow overriding. For example, this will fail

```
restart;
module ODE()
   option object;
   local ode;
   local id::integer;
```

```
   export set_ode::static:=proc(_self,ode,$)
     print("Enter ode::set_ode");
     _self:-ode :=ode;
   end proc;

  export get_ode::static:=proc(_self,$)
     return _self:-ode;
   end proc;
end module;

module second_order_ode()
   option object(ODE);
   local id::string;
   export get_ode_order::static:=proc(_self,$)
      return 2;
   end proc;
end module;

    Error, (in second_order_ode) local `id` is declared more than once
```

There might be a way to handle this, i.e. to somehow exlicitly tell Maple to override parant class proc or variable name in the child. I do not know now. The above is using Maple 2021.1

142 How to use object as user defined record inside a proc?

A Maple Object can be used a record type in other languags, such as Ada or Pascal. This example shows how to define a local type inside a proc and use it as record.

```
restart;
foo:=proc(name::string,age::integer)::person_type;
     local person_type:=module() #this acts as a record type
         option object;
         export name::string;
         export age::integer;
     end module;

     local person::person_type:=Object(person_type);

     person:-name:=name;
     person:-age:=age;
     return person;
 end proc;

o:=foo("joe doe",100);
```

```
o:-name;
                              "joe doe"
o:-age;
                                 100
```

In the above person is local variable of type person_type. In the above example, the local variable was returned back to user. But this is just an example. One can declare such variables and just use them internally inside the proc only. This method helps one organize related variables into one record type. The type can also be made global if needed.

143 Given an expression with indexed variables, how to select only these variables?

use indets with type 'indexed'

```
expr:=16*a[3]+6*a[1];
terms:=indets(expr,'indexed');

         terms := {a[1], a[3]}

#to find maximum index, then do

map(x->op(x),terms)

      {1, 3}
```

144 How to show step by step for calculus problem?

For integration do

```
Student:-Calculus1:-ShowSolution(Int(x*sin(x),x));
```

The steps are displayed. This does not work all the time. For example

```
integrand:=x*y(x)*diff(y(x),x$2)+x*(diff(y(x),x))^2-y(x)*diff(y(x),x);
Student:-Calculus1:-ShowSolution(Int(integrand,x));
```

gives

```
Error, (in Student:-Calculus1:-ShowSolution) unable to determine which calculus operati
being applied in this problem; you can provide this information as the 2nd argument on
call to Rule or Hint
```

145 How to obtain list of files with some extension in folder?

Use `FileTools:-ListDirectory`

```
dir_name:="C:/tmp";
currentdir(dir_name); #cd to directory
files_to_process := FileTools:-ListDirectory(dir_name,'all','returnonly'="*.tex
    "):
numelems(files_to_process)
    100
```

In the above, `files_to_process` is a list of the files in the current folder with extension .tex

146 How to delete lines from text file that contains some string?

There was a case when I needed to delete lines from text file that contains a say ”foo” as an example.

This is what I did. use readline to read the lines, check, and if the line contains ”foo” skip, else write the line to a temporary file. At the line, use Rename to rename the temporary file to the file being read.

```
dir_name:="C:/tmp";
currentdir(dir_name);

tmp_file_name      := "TMP.txt";
source_file_name   := "source.txt";
file_id            := fopen(tmp_file_name,WRITE):
line               := readline(source_file_name):

while line<>0 do

   if not StringTools:-Has(line,"foo") then
      fprintf(file_id,"%s\n",line);
   fi;

   line := readline(source_file_name):
od:

fclose(file_id);
FileTools:-Rename(tmp_file_name,source_file_name,force=true);
```