Maple

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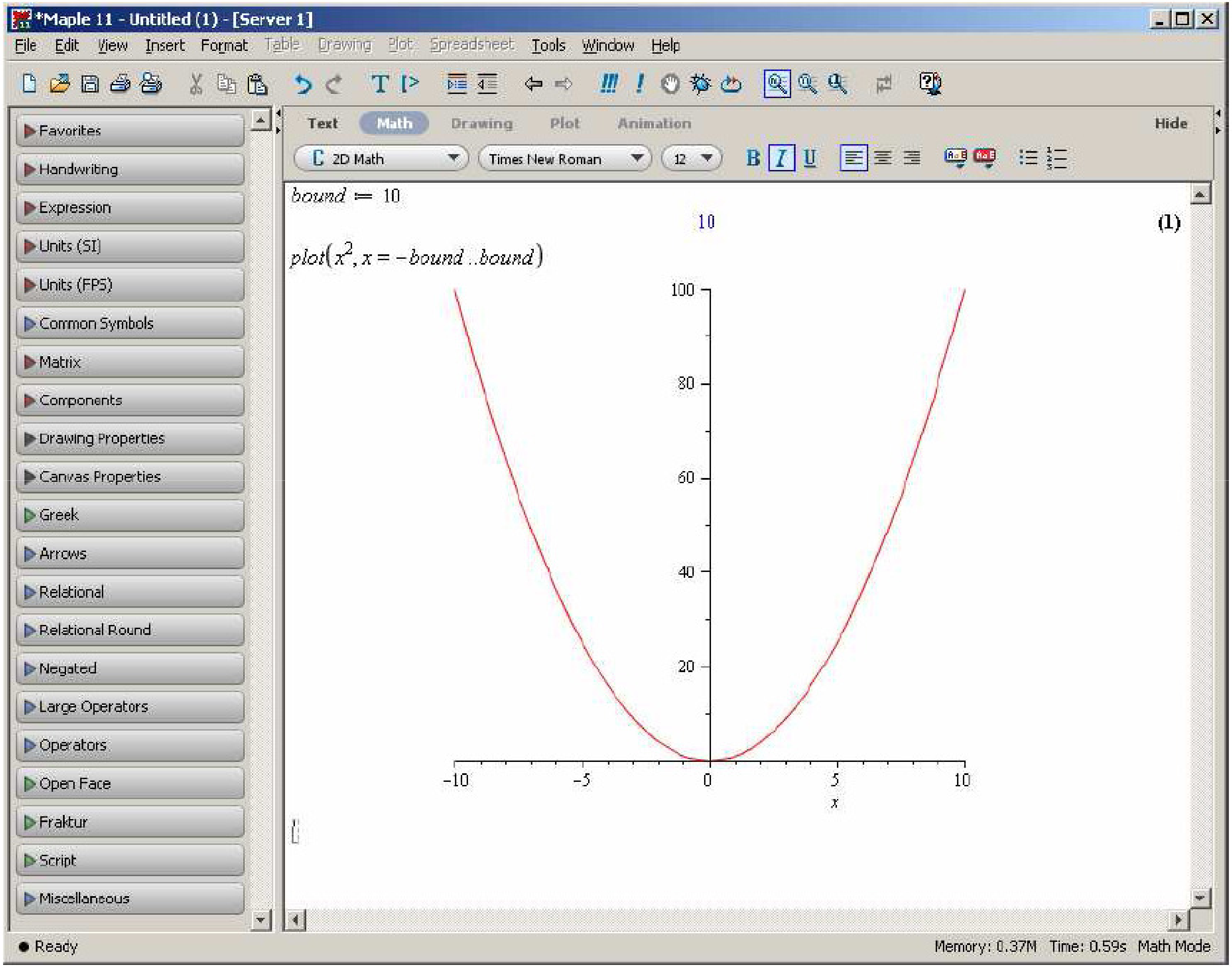
*Maple 11 - Untitled (1) - [Server 1]
File Edit View Insert Format Table Drawing Plot Spreadsheet Tools Window Help
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12
bound := 10
10
(1)
plot(x^2, x = -bound..bound)
100
80
60
40
20
-10
-5
0
5
10
x
Ready
Memory: 0.37M Time: 0.59s Math Mode

> $1+2$

$$3$$

Operations	**Arithmetic Operators**	**Examples**
Addition	+	1+2
Subtraction	-	x-y
Multiplication	*	54*4
Division	/	x/y
Exponentiation	^ or **	2^3 or 2**3

> $expression1 := x^2 + x + 2$

$$x^2 + x + 2$$

Example: Creating an expression sequence

> $5, 6, 3, 4, x$

$$5, 6, 3, 4, x$$

> a, b, c, d, e

$$a, b, c, d, e$$

> $seq(i^2, i = 2..4)$

$$4, 9, 16$$

Example: Defining a List

> $list1 := [1, 1, 5, 5, 3]$

$$[1, 1, 5, 5, 3]$$

> $\frac{9}{8} + \frac{6}{5}$

$$\frac{93}{40}$$

> $evalf(\%)$

$$2.325000000$$

> $\frac{9.0}{8} + \frac{6}{5}$

$$2.325000000$$

> 100^{50}

10000000000000000000000000000000000000000000000000000000000000000000000\
000000000000000000000000000000

> $\frac{(3 + 3\,I)}{(2 + 6\,I)}$

$$\frac{3}{5} - \frac{3}{10}\,\mathrm{I}$$

Symbolic Computations on Expressions

> $simplify\left(\sin(x)^2 \cdot x^5 + \cos(x)^2 \cdot x^5\right)$

Simplifying an expression

$$x^5$$

> $simplify\left(\sin(x)^2 \cdot x^5 + \cos(x)^2 \cdot x^5, 'ln'\right)$

$$\sin(x)^2\, x^5 + \cos(x)^2\, x^5$$

> $expand\left(\left(x+5\right) \cdot (x+3)\right)$

$$x^2 + 8\,x + 15$$

> $factor\left(x^2 + 2\,x - 3\right)$

$$(x+3)\,(x-1)$$

> $normal\left(\frac{x^5}{(x+1)} + \frac{x^4}{(x+1)}\right)$

 # canceling out numerator and denominator common factor (x + 1)

$$x^4$$

Equations

> $x = y + 2$

$$x = y + 2$$

Defining Equations

> $solve\left(\left\{x1 + x2 = \frac{5}{6}, 2\,x1 + 5\,x2 = \frac{7}{8}\right\}, \{x1, x2\}\right)$

$$\left\{x2 = -\frac{19}{72}, x1 = \frac{79}{72}\right\}$$

Solving Equations

> $fsolve\left(\left\{x1 + x2 = \frac{5}{6}, 2\,x1 + 5\,x2 = \frac{7}{8}\right\}, \{x1, x2\}\right)$

float number solution

$$\{x1 = 1.097222222, x2 = -.2638888888\}$$

Functions

> $f := x \rightarrow x^5 + 6\,x$

$$x \rightarrow x^5 + 6\,x$$

> $f(1)$ # *Evaluate the function f(x) when x=1*

$$7$$

> $f := (x, y) \rightarrow x^2 + y^2$

<u>Defining a Function With Multiple Variables</u>

$$(x, y) \rightarrow x^2 + y^2$$

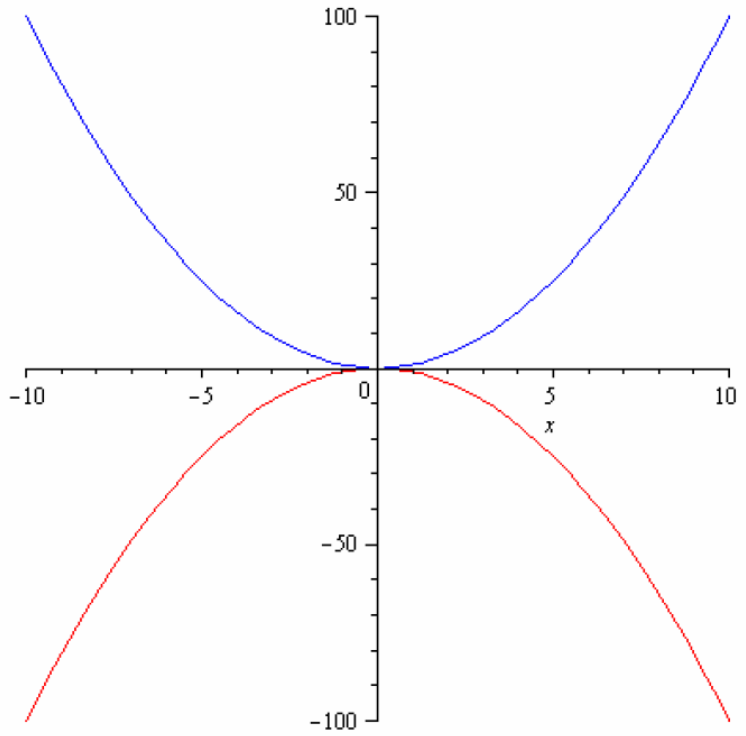
> $f(1, 1)$

$$2$$

Graphics

> $plot\left(x^3 + 5\,x^2, x = -10\,..10\right)$

> $plot\left(\left[x^2, -x^2\right], x = -10\,..10, color = [blue, red]\right)$

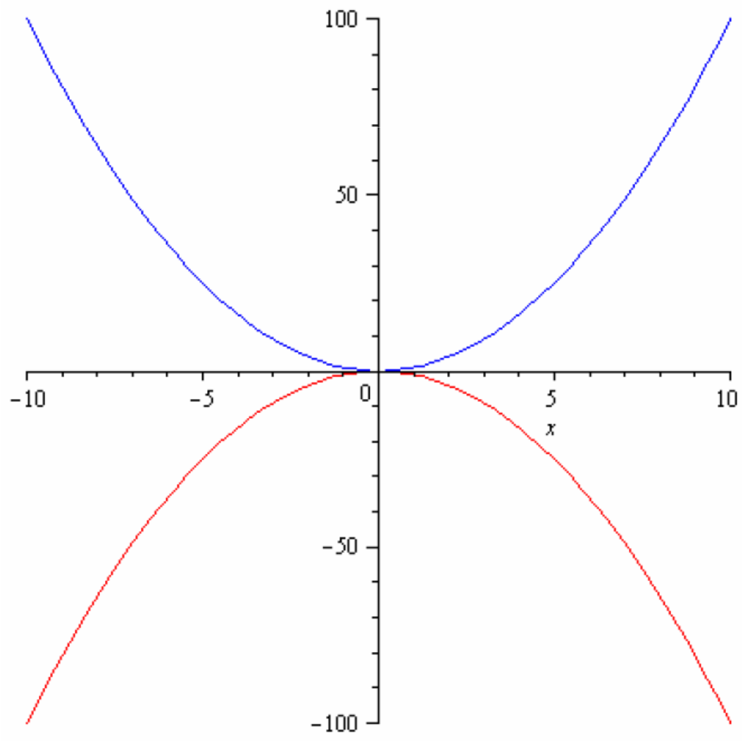


> $with(plots)$

> $graph1 := plot(x^2, x = -10..10, color = blue):$

> $graph2 := plot(-x^2, x = -10..10, color = red):$

> $display(graph1, graph2)$



Calculus

Differentiations

- **diff(*expr*,*x*)** #Computing the derivative of the expression *expr* # with respect to *x*
- **diff(*expr*,*x*$*i*)** #Computing the *ith*-order derivative of the expression # *expr* with respect to *x*

> $expr := x^5$ *# assign an expression name. Here we call it expr*

$$x^5$$

> *diff* (*expr*, *x*) *# compute the derivative of expr with respect to x*

$$5\,x^4$$

> *diff* (*expr*, *x*$2) *# compute the second-order derivative of expr*

$$20\,x^3$$

> *diff* (*expr*, *x*$5) *# compute the fifth-order derivative of expr*

$$120$$

compute multiple-variable derivatives.

- **diff(*expr*, x_1,x_2,x_3,...,x_m)**; #computing the partial derivative of an #expression *expr* with respect to # x_1,x_2,...x_m respectively.
- **diff(*expr*,x_1\$$n_1$,$x_2$\$$n_2$,..$x_m$\$$n_m$);** #computing the n_1th-*order* partial derivative #of the expression *expr* with respect to x_1, # the n_2th-*order* partial derivative of *expr* # with respect to x_2..... and the n_mth-*order* #partial derivative of *expr* with respect to x_m

---

> *expr* := $x^4y^5z^2$; *# Define the expression expr*

$$x^4\,y^5\,z^2$$

> *diff*(*expr*, *x*, *y*, *z*); *# Compute the partial derivative of expr #with respect to x,y,z, respectively*

$$40\,x^3\,y^4\,z$$

> *diff*(*expr*, *x*\$4, *y*\$5, *z*);
 # Computer the 4th-order partial derivative of expr

 # with respect to x, the fifth-order partial derivative

# of expr with respect to y and the first-order partial
 # derivative of expr with respect to z.

$$5760\,z$$

Integrals

- **int(*exp*,*x*)** is the syntax used for computing the indefinite integral of the expression *exp* with respect to the variable *x*.

> $expr := x \cdot \exp(x)$; # *Define the expression expr*

$$x\,e^{x}$$

> $int(expr, x)$ # *Compute the integral of expr with respect to x*

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

Definite Integrals

- **int(*exp*,*x*=*a*..*b*)** is the syntax used for computing the definite integral of the expression *exp* with respect to the variable *x* between the interval [*a*,*b*].

> $expr := \frac{1}{(1+x^2)}$; # *Define the expression expr*

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

> $int(expr, x = 0\,..10)$ # *Compute the definite integral of expr*

$$\arctan(10)$$

> $evalf(\%)$ # *Convert arctan(10) to floating point number result*

$$1.47112767\text{‹}$$

Limit Function

```
> expr := (3*x^2 + 5)/(4*x^2 + 7); # Define the expression expr
```

$$\frac{3\,x^2+5}{4\,x^2+7}$$

```
> limit(expr, x = infinity) # Find the limit as x approaches  infinity
```

$$\frac{3}{4}$$

```
> limit((exp(x)-1)/sin(x), x = 0)  #Find the limit as x approaches 0
```

$$1$$

Linear Algebra

Vectors

- **vector([x_1,x_2...x_n])** or **vector(n, [x_1,x_2,...x_n])**; #Creating a vector of length n #containing the given elements # x_1,x_2,...x_n .
- **vector(n)**; # Creating a vector of length n with unspecified elements.

```
> with(linalg) # Load the linalg package
```

```
> a := vector([1, 2, 3, 4, 5])  # Define the vector a
                                   [ 1  2  3  4  5 ]
```

```
> b := vector(3, [1, 2, 3])
                                   [ 1  2  3 ]
```

```
> b := vector(4)
                                   array(1 ..4, [ ])
```

```
> a := vector([1, 2, 3, 4, 5]) #  Define the vector a
                                   [ 1  2  3  4  5 ]
> a[2]
                                   2
```

Vector Algebra

- **evalm(c*v1);** # Multiply each element of the vector *v1* by scalar *c*
- **evalm(v1+v2);** # Sum of the vector *v1* and *v2* (*v1* and *v2* must
have the same length).
- **evalm(v1-v2);** # Difference of the vector *v1* and *v2* (*v1* and *v2*
must have the same length).
- **dotprod(v1,v2);** #Dot product of the vector *v1* and *v2*
(*v1* and *v2* must have the same length).
#Sum the v1[i]*v2[i], as *i* ranges over
the length of *v1* and *v2*
- **crossprod(v1,v2);** # (*v1* and *v2* must be *3*-element vectors). The cross product
# of vector *v1* and vector *v2* is defined:
[v1[2]*v2[3]-v1[3]*v2[2], v1[3]*v2[1]-v1[1]*v2[3],
v1[1]*v2[2]-v1[2]*v2[1]].

> $v1 := vector(3, [1, 2, 3])$

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

> $v2 := vector(3, [-4,-2,-1])$

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

> $evalm(2*v1)$

$$\begin{bmatrix} 2 & 4 & 6 \end{bmatrix}$$

> $evalm(-3*v2)$

$$\begin{bmatrix} 12 & 6 & 3 \end{bmatrix}$$

> $evalm(v1-v2)$

$$\begin{bmatrix} 5 & 4 & 4 \end{bmatrix}$$

> $evalm(v1 + v2)$

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

> $v1 := vector(3, [1, 2, 3])$

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

> $v2 := vector(3, [-4,-2,-1])$

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

> $dotprod(v1, v2)$

$$-11$$

> $crossprod(v1, v2)$

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

Matrices

- **A:=array(*1..m,1..n*);** # A matrix with *m* rows and *n* columns
- **A:=matrix(*m,n*,[*..list f elements..*]);**#a matrix with *m* rows and *n* columns
  #with specified elements

> $with(linalg)$

> $A := matrix(2, 2, [1, 3, 5, 4])$

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

- **swaprow(*A,i,j*);** # Interchange the row *i* and row *j* of matrix *A*
- **delrows(*A,i..j*);** # Return the submatrix of the matrix *A*, which is
  # obtained by deleting rows *i* through *j*
- **addrow(*A,i,j,c*);** #Return a copy of the matrix *A* in which
  #row r_j is replaced by $c*row(A, r_i) + row(A, r_j)$.

> $A := matrix(2, 2, [1, 3, 5, 4])$

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

> $swaprow(A, 1, 2)$

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

> $A := matrix(3, 3, [1, 1, 1, 2, 2, 2, 3, 3, 3])$

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

> $A11 := delrows(A, 1..2)$

$$\begin{bmatrix} 3 & 3 & 3 \end{bmatrix}$$

> $A22 := addrow(A, 1, 2, -2)$

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

Matrix Algebra

- **inverse(*A*);** # Inverse of matrix *A*
- **det(*A*);** # Determinant of matrix *A*
- **transpose(*A*);** # Transpose of matrix *A*
- **evalm(*c***A*);** # Multiplying each element of matrix *A* by a scalar *c*

> $A := matrix(2, 2, [1, 3, 5, 6])$ *# Define a matrix A*

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

> $inverse(A)$ *# Compute the inverse of A*

$$\begin{bmatrix} -\frac{2}{3} & \frac{1}{3} \\ \frac{5}{9} & -\frac{1}{9} \end{bmatrix}$$

```
> det(A) # Compute the determinant of A
```

$$-9$$

```
> transpose(A) #Compute the transpose of A
```

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

```
> evalm(2*A) # Multiply a matrix by a constant
```

$$\begin{bmatrix} 2 & 6 \\ 10 & 12 \end{bmatrix}$$

Multiple Matrix and Vector Operations

- **multiply(*A*,*v*);** # Matrix-vector product *A*v*. The number of entries in *v* # must be equal to the number of columns of *A*
- **evalm(*A*+*B*);** #Sum of the matrix *A* and *B*. *A* and *B* must have # the same numbers of rows and columns.
- **evalm(*A*-*B*);** #Difference of the matrix *A* and *B*. *A* and *B* must have #the same numbers of rows and columns.
- **multiply(*A*, *B*);** #Calculate the matrix product *A*B*; The dimensions of #each matrix must be consistent with the rules of matrix # multiplication.

> $A := matrix(2, 2, [1, 2, 3, 4])$ *#Define the Matrix A*

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

> $v := vector(2, [1, 1])$ *# Define the vector v*

$$\begin{bmatrix} 1 & 1 \end{bmatrix}$$

> $multiply(A, v)$ *# Multiply A and v*

$$\begin{bmatrix} 3 & 7 \end{bmatrix}$$

> $A := matrix(2, 2, [1, 2, 3, 4])$ # *Define the matrix A*

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

> $B := matrix(2, 2, [-1,-2,-3,-4])$ # *Define the matrix B*

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

> $evalm(A + B)$ # *Add A and B*

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

> $evalm(A-B)$ # *Subtract B from A*

$$\begin{bmatrix} 2 & 4 \\ 6 & 8 \end{bmatrix}$$

> $multiply(A, B)$ # *Multiply the matrices A and B*

$$\begin{bmatrix} -7 & -10 \\ -15 & -22 \end{bmatrix}$$

Eigenvectors and Eigenvalues

> $with(linalg)$

> $m := matrix(3, 3, [2, 3, 4, 5, 6, 7, 8, 7, 6])$

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

> $v := eigenvalues\,(m)$

$$0, 7 + \sqrt{85}, 7 - \sqrt{85}$$

> $A := matrix(2, 2, [2, 3, 4, 5])$

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

> $V := eigenvectors\,(A)$

$$\left[\frac{7}{2} + \frac{1}{2}\sqrt{57}, 1, \left\{\left[\begin{array}{cc} 1 & \frac{1}{2} + \frac{1}{6}\sqrt{57} \end{array}\right]\right\}\right], \left[\frac{7}{2} - \frac{1}{2}\sqrt{57}, 1, \left\{\left[\begin{array}{cc} 1 & \frac{1}{2} - \frac{1}{6}\sqrt{57} \end{array}\right]\right\}\right]$$

REFERENCES

http://www.maplesoft.com/academic/students/tutorials.aspx