Espressione algebriche numeriche

In[1]:=

```
1 2 - 3 ((4 - 5/6)^(-7) - 8(9 + 10)^11)
```

Out[1]=

$$\frac{2499056407149871583691854}{893871739}$$

In[2]:=

```
100!
```

Out[2]=

```
93326215443944152681699238856266700490715\
  1596826438162146859296389521759999322\
  9915608941463976156518286253697920827\
  2237582511852109168640000000000000000\
  00000000
```

In[3]:=

```
Product[2 n - 1,{n,1,100}]
```

Out[3]=

```
6666308670072953744411215006735034163322\
  4489389674388736363184954745922258576\
  8965184146259152831284243904743177081\
  7689351184195401526717658740566680191\
  2441638268530971962511539459228515625
```

```
In[4]:=
 Sum[1/5^n,{n,1,50}]
Out[4]=
 22204460492503130808472633361816406
 -----------------------------------
 88817841970012523233890533447265625
In[5]:=
 FactorInteger[%]
Out[5]=
 {{2, 1}, {3, 1}, {5, -50}, {11, 1},
   {71, 1}, {101, 1}, {251, 1},
   {401, 1}, {521, 1}, {1901, 1},
   {9384251, 1}, {50150933101, 1}}
In[6]:=
 N[%%]
Out[6]=
 0.25
In[7]:=
 Sum[1/5^n,{n,1,Infinity}]
Out[7]=
 1
 -
 4
In[8]:=
 (Sqrt[2]^5 - 2 Sqrt[2])^2 (2/3)^(1/2)
Out[8]=
           2
 8 Sqrt[-]
           3
```

```
In[9]:=
 N[%,20]
Out[9]=
 6.5319726474218082

In[10]:=
 % / 8
Out[10]=
 0.81649658092772603

In[11]:=
 %^2
Out[11]=
 0.66666666666666667

In[12]:=
 Rationalize[%]
Out[12]=
 2
 -
 3

In[13]:=
 N[E,100]
Out[13]=
 2.7182818284590452353602874713526624977\
   5724709369995957496696762772407663035\
   354759457138217852516642 7

In[14]:=
 N[Pi,100]
Out[14]=
 3.1415926535897932384626433832795028841\
   9716939937510582097494459230781640628\
   620899862803482534211706 8
```

In[15]:=

```
Sin[%]
```

Out[15]=

```
      -104
0. 10
```

In[16]:=

```
Sin[Pi]
```

Out[16]=

```
0
```

In[17]:=

```
Sin[Pi/4]
```

Out[17]=

```
   1
-------
Sqrt[2]
```

In[18]:=

```
(1/2 - 3 I)^4 - 5/6 I
```

Out[18]=

```
1081   155 I
---- + -----
 16      3
```

In[19]:=

```
N[%]
```

Out[19]=

```
67.5625 + 51.6667 I
```

In[20]:=

```
E^(Pi I)
```

Out[20]=

```
-1
```

Espressione algebriche simboliche

In[21]:=

```
4/3 a + a^2 b a + 2/3 a
```

Out[21]=

$$2\,a + a^3\,b$$

In[22]:=

```
HoldForm[4/3 a + a^2 b a + 2/3 a]
```

Out[22]=

$$\frac{4\,a}{3} + a^2\,b\,a + \frac{2\,a}{3}$$

In[23]:=

```
(2 a x^2 + 1) (x + y)^3
```

Out[23]=

$$(1 + 2\,a\,x^2)\,(x + y)^3$$

In[24]:=

```
Expand[%]
```

Out[24]=

$$x^3 + 2\,a\,x^5 + 3\,x^2\,y + 6\,a\,x^4\,y + 3\,x\,y^2 + 6\,a\,x^3\,y^2 + y^3 + 2\,a\,x^2\,y^3$$

In[25]:=

```
Factor[%]
```

Out[25]=

$$(1 + 2\,a\,x^2)\,(x + y)^3$$

```
In[26]:=
 (Sqrt[6] + Sqrt[2]/3)^2
Out[26]=
  Sqrt[2]             2
 (------- + Sqrt[6])
     3
In[27]:=
 Expand[%]
Out[27]=
 56       4
 -- + -------
 9    Sqrt[3]
In[28]:=
 Factor[%]
Out[28]=
 4 (14 + 3 Sqrt[3])
 ------------------
         9
In[29]:=
 E^(2/3 Pi I)
Out[29]=
  (2 I)/3 Pi
 E
In[30]:=
 ComplexExpand[%]
Out[30]=
    1     I
 -(-) + - Sqrt[3]
    2     2
In[31]:=
 Expand[%^3]
Out[31]=
 1
```

```
In[32]:=
 (1 + (Sin[x] + Cos[x])^2)/
                   (1 + Sin[x] Cos[x])
Out[32]=
                       2
 1 + (Cos[x] + Sin[x])
 ---------------------
   1 + Cos[x] Sin[x]
In[33]:=
 Expand[%]
Out[33]=
                                   2
         1                   Cos[x]
 ----------------- + ----------------- +
 1 + Cos[x] Sin[x]   1 + Cos[x] Sin[x]

                                     2
   2 Cos[x] Sin[x]             Sin[x]
   ----------------- + -----------------
   1 + Cos[x] Sin[x]   1 + Cos[x] Sin[x]
In[34]:=
 Factor[%]
Out[34]=
               2
 (1 + Cos[x]  + 2 Cos[x] Sin[x] +

           2
     Sin[x] ) / (1 + Cos[x] Sin[x])
In[35]:=
 Simplify[%]
Out[35]=
 2
```

In[36]:=

```
(2(x - 1)^8 - 2)/(2 x)
```

Out[36]=

$$\frac{-2 + 2\,(-1 + x)^{8}}{2\,x}$$

In[37]:=

```
Simplify[%]
```

Out[37]=

$$\frac{-2 + 2\,(-1 + x)^{8}}{2\,x}$$

In[38]:=

```
Expand[%]
```

Out[38]=

$$-8 + 28\,x - 56\,x^{2} + 70\,x^{3} - 56\,x^{4} + 28\,x^{5} - 8\,x^{6} + x^{7}$$

In[39]:=

```
Factor[%]
```

Out[39]=

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

Vettori e matrici

In[40]:=

```
{1,2,3} + a {x,y,z}                 (* vettori *)
```

Out[40]=

```
{1 + a x, 2 + a y, 3 + a z}
```

In[41]:=

```
%[[1]]              (* elemento di indice 1 *)
```

Out[41]=

```
1 + a x
```

In[42]:=

```
%%[[2]]             (* elemento di indice 2 *)
```

Out[42]=

```
2 + a y
```

In[43]:=

```
{1,2,3} {x,y,z}
```

Out[43]=

```
{x, 2 y, 3 z}
```

In[44]:=

```
{1,2,3} . {x,y,z}                   (* vet.vet *)
```

Out[44]=

```
x + 2 y + 3 z
```

In[45]:=

```
{{a,b},{c,d}}                       (* matrici *)
```

Out[45]=

```
{{a, b}, {c, d}}
```

In[46]:=

```
MatrixForm[%]
```

Out[46]//MatrixForm=

```
a   b

c   d
```

In[47]:=

```
%[[1,1]]     (* elemento di indici 1,1 *)
```

Out[47]=

a

In[48]:=

```
%%[[1,2]]    (* elemento di indici 1,2 *)
```

Out[48]=

b

In[49]:=

```
MatrixForm[%%% . {x,y}]     (* mat.vet *)
```

Out[49]//MatrixForm=

$$\begin{matrix} a\, x + b\, y \\ c\, x + d\, y \end{matrix}$$

In[50]:=

```
%%%% . %%%% // MatrixForm   (* mat.mat *)
```

Out[50]//MatrixForm=

$$\begin{matrix} a^2 + b\, c & a\, b + b\, d \\ a\, c + c\, d & b\, c + d^2 \end{matrix}$$

In[51]:=

```
Det[%]
```

Out[51]=

$$b^2\, c^2 - 2\, a\, b\, c\, d + a^2\, d^2$$

In[52]:=

```
Factor[%]
```

Out[52]=

$$(b\, c - a\, d)^2$$

```
In[53]:=
 IdentityMatrix[4] // MatrixForm
Out[53]//MatrixForm=
 1   0   0   0

 0   1   0   0

 0   0   1   0

 0   0   0   1
In[54]:=
 ? *Matrix*
 DiagonalMatrix MatrixPower
 IdentityMatrix MatrixQ
 MatrixExp      Plot3Matrix
 MatrixForm
In[55]:=
 DiagonalMatrix[{1,2,3,4}] // MatrixForm
Out[55]//MatrixForm=
 1   0   0   0

 0   2   0   0

 0   0   3   0

 0   0   0   4
In[56]:=
 Eigenvalues[%]
Out[56]=
 {1, 2, 3, 4}
In[57]:=
 ? Eigen*
 Eigensystem  Eigenvalues  Eigenvectors
```

In[58]:=

```
Array[m,{5}]
```

Out[58]=

```
{m[1], m[2], m[3], m[4], m[5]}
```

In[59]:=

```
Array[m,{3,3}] // MatrixForm
```

Out[59]//MatrixForm=

```
m[1, 1]   m[1, 2]   m[1, 3]
m[2, 1]   m[2, 2]   m[2, 3]
m[3, 1]   m[3, 2]   m[3, 3]
```

In[60]:=

```
%[[3,2]]
```

Out[60]=

```
m[3, 2]
```

In[61]:=

```
Array[Plus,{3,3}] // MatrixForm
```

Out[61]//MatrixForm=

```
2   3   4
3   4   5
4   5   6
```

Liste

In[62]:=

```
Table[n!,{n,1,8}]
```

Out[62]=

```
{1, 2, 6, 24, 120, 720, 5040, 40320}
```

In[63]:=

```
Table[n m,{n,4},{m,8}] // MatrixForm
```

Out[63]//MatrixForm=

1	2	3	4	5	6	7	8
2	4	6	8	10	12	14	16
3	6	9	12	15	18	21	24
4	8	12	16	20	24	28	32

In[64]:=

```
Table[Range[i],{i,0,5}]
```

Out[64]=

```
{{}, {1}, {1, 2}, {1, 2, 3},
  {1, 2, 3, 4}, {1, 2, 3, 4, 5}}
```

In[65]:=

```
%[[4]]
```

Out[65]=

```
{1, 2, 3}
```

In[66]:=

```
%%[[5,3]]
```

Out[66]=

```
3
```

In[67]:=

```
%%%[[{5,3}]]
```

Out[67]=

```
{{1, 2, 3, 4}, {1, 2}}
```

```
In[68]:=
 Join[Array[Sqrt,3],Range[3,1,-1]]
Out[68]=
 {1, Sqrt[2], Sqrt[3], 3, 2, 1}
In[69]:=
 Join[%,Range[2]]
Out[69]=
 {1, Sqrt[2], Sqrt[3], 3, 2, 1, 1, 2}
In[70]:=
 Union[%%,Range[2]]
Out[70]=
 {1, 2, 3, Sqrt[2], Sqrt[3]}
In[71]:=
 Append[%,Range[2]]
Out[71]=
 {1, 2, 3, Sqrt[2], Sqrt[3], {1, 2}}
In[72]:=
 Prepend[%,1]
Out[72]=
 {1, 1, 2, 3, Sqrt[2], Sqrt[3], {1, 2}}
In[73]:=
 %^2
Out[73]=
 {1, 1, 4, 9, 2, 3, {1, 4}}
In[74]:=
 Flatten[%]
Out[74]=
 {1, 1, 4, 9, 2, 3, 1, 4}
```

```
In[75]:=
 Union[%]
Out[75]=
 {1, 2, 3, 4, 9}
In[76]:=
 Map[f,%]
Out[76]=
 {f[1], f[2], f[3], f[4], f[9]}
In[77]:=
 Apply[Plus,%]
Out[77]=
 f[1] + f[2] + f[3] + f[4] + f[9]
In[78]:=
 ? Map
 Map[f, expr] or f /@ expr applies f to
    each element on the first level in
    expr. Map[f, expr, levelspec] applies
    f to parts of expr specified by
    levelspec.
In[79]:=
 ? Apply
 Apply[f, expr] or f @@ expr replaces the
    head of expr by f. Apply[f, expr,
    levelspec] replaces heads in parts of
    expr specified by levelspec.
In[80]:=
 Inner[f,{x1,x2,x3},{y1,y2,y3},g]
Out[80]=
 g[f[x1, y1], f[x2, y2], f[x3, y3]]
```

In[81]:=

```
Inner[Times,{x1,x2,x3},{y1,y2,y3},Plus]
```

Out[81]=

```
x1 y1 + x2 y2 + x3 y3
```

In[82]:=

```
Outer[f,{x1,x2},{y1,y2,y3}]
```

Out[82]=

```
{{f[x1, y1], f[x1, y2], f[x1, y3]},
  {f[x2, y1], f[x2, y2], f[x2, y3]}}
```

In[83]:=

```
Outer[List,{x1,x2},{y1,y2,y3}]
```

Out[83]=

```
{{{x1, y1}, {x1, y2}, {x1, y3}},
  {{x2, y1}, {x2, y2}, {x2, y3}}}
```

In[84]:=

```
? Inner
Inner[f, list1, list2, g] is a
   generalization of Dot in which f
   plays the role of multiplication and
   g of addition.
```

In[85]:=

```
? Outer
```

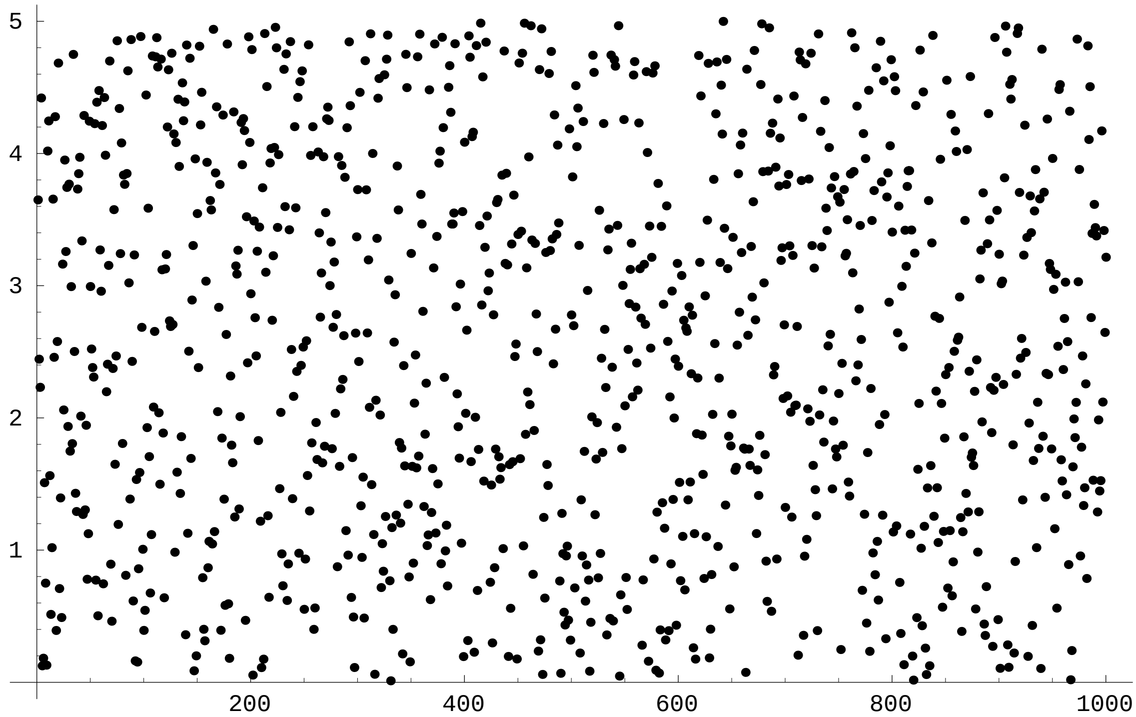
Outer[f, list1, list2, ...] gives the generalized outer product of the listi, forming all possible combinations of the lowest-level elements in each of them. Outer[f, list1, list2, ... , n] treats as separate elements only sublists at level n in the listi. Outer[f, list1, list2, ... , n1, n2, ...] treats as separate elements only sublists at level ni in the corresponding listi.

In[86]:=

```
Table[Random[Real,{0,5}],{i,1,1000}];
```

In[87]:=

```
ListPlot[%]
```

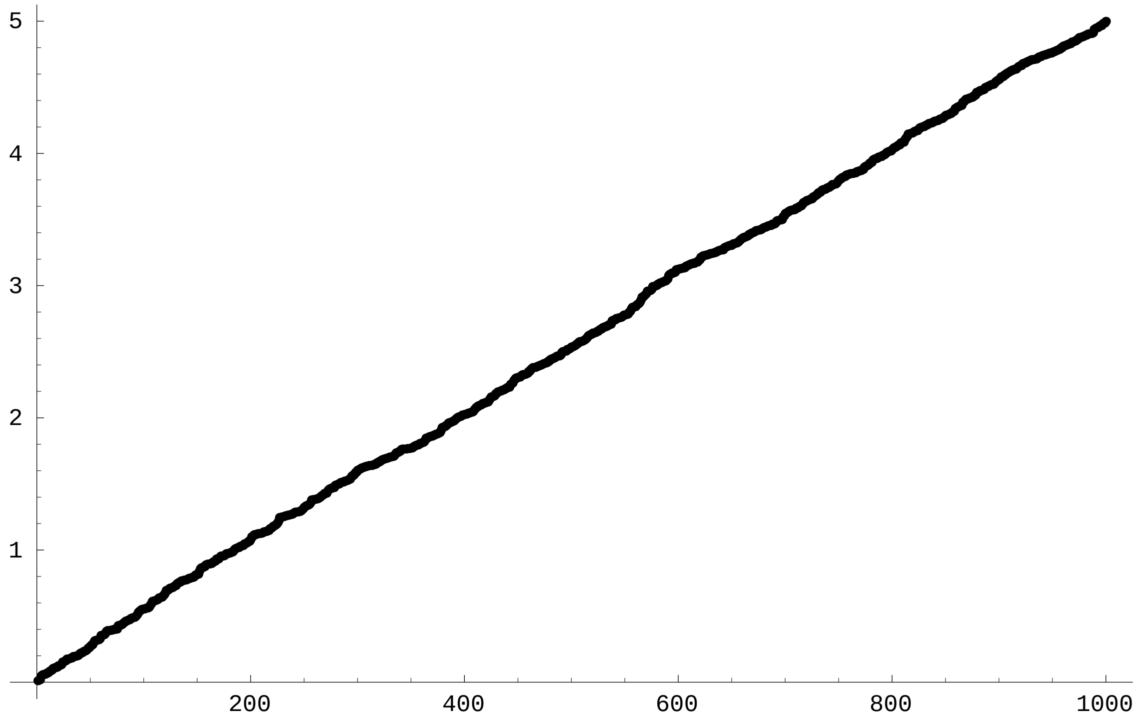


Out[87]=

-Graphics-

In[88]:=

```
ListPlot[Sort[%%]];
```



Espressioni atomiche

In[89]:=
```
FullForm[-1]                (* numeri interi *)
```
Out[89]//FullForm=
```
-1
```
In[90]:=
```
Head[%]
```
Out[90]=
```
Integer
```
In[91]:=
```
FullForm[0.2345]         (* numeri "reali" *)
```
Out[91]//FullForm=
```
0.23449999999999999
```
In[92]:=
```
Head[%]
```
Out[92]=
```
Real
```
In[93]:=
```
FullForm[a]                        (* simboli *)
```
Out[93]//FullForm=
```
a
```
In[94]:=
```
Head[%]
```
Out[94]=
```
Symbol
```
In[95]:=
```
FullForm[ab]
```
Out[95]//FullForm=
```
ab
```

```
In[96]:=
 FullForm[Pi]
Out[96]//FullForm=
 Pi
In[97]:=
 FullForm[I]
Out[97]//FullForm=
 Complex[0, 1]
In[98]:=
 FullForm[Sin]
Out[98]//FullForm=
 Sin
In[99]:=
 FullForm[FullForm]
Out[99]//FullForm=
 FullForm
In[100]:=
 FullForm[C60]   (* questo è un simbolo *)
Out[100]//FullForm=
 C60
In[101]:=
 FullForm[60C]        (* ... questo no! *)
Out[101]//FullForm=
 Times[60, C]
```

Espressioni composte

In[102]:=
```
FullForm[-1/2]     (* numeri razionali *)
```
Out[102]//FullForm=
```
Rational[-1, 2]
```
In[103]:=
```
Head[%]
```
Out[103]=
```
Rational
```
In[104]:=
```
FullForm[3 - 4 I]  (* numeri complessi *)
```
Out[104]//FullForm=
```
Complex[3, -4]
```
In[105]:=
```
Head[%]
```
Out[105]=
```
Complex
```
In[106]:=
```
FullForm[5/6 + 7.89 I]
```
Out[106]//FullForm=
```
Complex[Rational[5, 6],
  7.889999999999999]
```
In[107]:=
```
FullForm[1 + Sqrt[2] I]
```
Out[107]//FullForm=
```
Plus[1, Times[Complex[0, 1],
   Power[2, Rational[1, 2]]]]
```

```
In[108]:=
 FullForm[a + b + c]
Out[108]//FullForm=
 Plus[a, b, c]
In[109]:=
 FullForm[a - b + c]
Out[109]//FullForm=
 Plus[a, Times[-1, b], c]
In[110]:=
 FullForm[a b c]
Out[110]//FullForm=
 Times[a, b, c]
In[111]:=
 FullForm[a/b c]
Out[111]//FullForm=
 Times[a, Power[b, -1], c]
In[112]:=
 FullForm[a b + c]
Out[112]//FullForm=
 Plus[Times[a, b], c]
In[113]:=
 FullForm[a (b + c)]
Out[113]//FullForm=
 Times[a, Plus[b, c]]
In[114]:=
 FullForm[{a,b,c}]                    (* liste *)
Out[114]//FullForm=
 List[a, b, c]
```

In[115]:=

```
FullForm[{{a,b},{c,d}}]
```

Out[115]//FullForm=

```
List[List[a, b], List[c, d]]
```

In[116]:=

```
FullForm[{{},{a},{{a},b}}]
```

Out[116]//FullForm=

```
List[List[], List[a], List[List[a], b]]
```

In[117]:=

```
FullForm[HoldForm[m[[i,j]]]]
```

Out[117]//FullForm=

```
HoldForm[Part[m, i, j]]
```

In[118]:=

```
e0[e1,e2,e3]
```

Out[118]=

```
e0[e1, e2, e3]
```

In[119]:=

```
Head[%]
```

Out[119]=

```
e0
```

In[120]:=

```
Part[%%,0]
```

Out[120]=

```
e0
```

In[121]:=

```
Part[%%%,1]
```

Out[121]=

```
e1
```

In[122]:=

```
Part[%%%%,2]
```

Out[122]=

```
e2
```

In[123]:=

```
Part[%%%%%,3]
```

Out[123]=

```
e3
```

In[124]:=

```
Part[%%%%%%,4]
```

```
Part::partw:
   Part 4 of e0[e1, e2, e3]
     does not exist.
```

Out[124]=

```
e0[e1, e2, e3][[4]]
```

In[125]:=

```
Apply[e0,{e1,e2,e3}]
```

Out[125]=

```
e0[e1, e2, e3]
```

In[126]:=

```
? Part
```

```
expr[[i]] or Part[expr, i] gives the ith
   part of expr. expr[[-i]] counts from
   the end. expr[[0]] gives the head of
   expr. expr[[i, j, ... ]] or
   Part[expr, i, j, ... ] is equivalent
   to expr[[i]] [[j]] ... . expr[[ {i1,
   i2, ... } ]] gives a list of the
   parts i1, i2, ...  of expr.
```