

COMPUTE · DEVELOP · DEPLOY

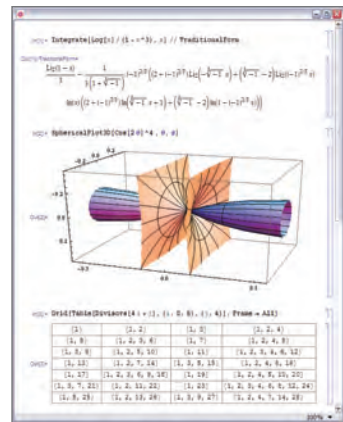
A QUICK OVERVIEW of *Mathematica*[®]

EXPLORE · LEARN · CREATE

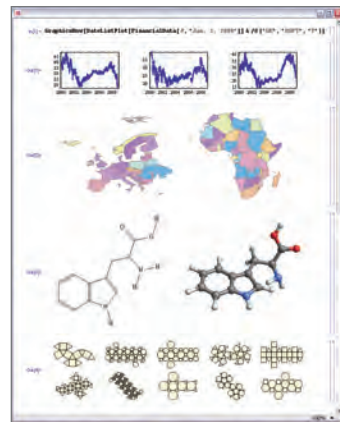
Mathematica is... a computing environment
 a language
 a vast knowledgebase

It's easy to start computing with *Mathematica*

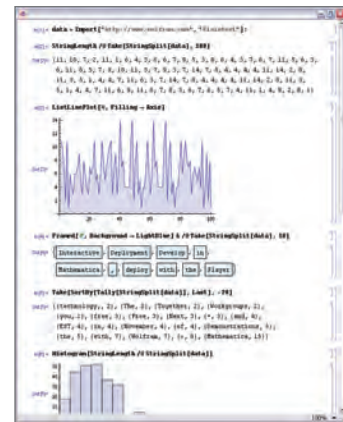
Ask your question; immediately get an answer



Do immediate *Mathematica* computation and visualization



Instantly access the *Mathematica* knowledgebase



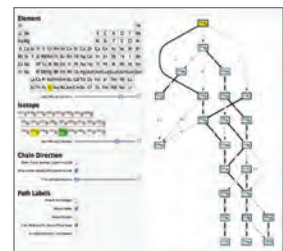
Build up a record of your work in a *Mathematica* notebook



Create an interactive *Mathematica* document or presentation



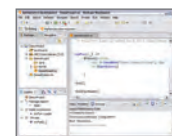
Write programs in the *Mathematica* language



Create a complete *Mathematica* application



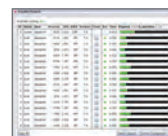
Use a deployed *Mathematica* application



Do large-scale *Mathematica* software engineering (API + IDE + server + runtime + ...)



Use *Mathematica* through the web



Run *Mathematica* on a parallel cluster

Type your input

Mathematica gives the result

Press Shift+Enter to evaluate your input

Build up a notebook as you work

Input and output are organized in "cells"

input cell

output cell

Rotate in 3D inline

In[1]:= Integrate[1/(x^5-1), x]

Out[1]= $\frac{1}{20} \left(-2\sqrt{2(5+\sqrt{5})} \operatorname{ArcTan}\left[\frac{1-\sqrt{5}+4x}{\sqrt{2(5+\sqrt{5})}}\right] - 2\sqrt{10-2\sqrt{5}} \operatorname{ArcTan}\left[\frac{1+\sqrt{5}+4x}{\sqrt{10-2\sqrt{5}}}\right] + 4\operatorname{Log}[-1+x] + (-1+\sqrt{5}) \operatorname{Log}\left[1-\frac{1}{2}(-1+\sqrt{5})x+x^2\right] - (1+\sqrt{5}) \operatorname{Log}\left[1+\frac{1}{2}(1+\sqrt{5})x+x^2\right] \right)$

In[2]:= Table[Sin[1.5 x]^2, {x, 0, 10}]

Out[2]= {0, 0.994996, 0.0199149, 0.955565, 0.078073, 0.879844, 0.169842, 0.773865, 0.28791, 0.646069, 0.422874}

In[3]:= Mean[%]

Out[3]= 0.475359

In[4]:= Plot3D[Sin[x+y^2], {x, -3, 3}, {y, -2, 2}]

Out[4]=

input → In[1]:= Integrate[1/(x^5-1), x]

output → Out[1]= $\frac{1}{20} \left(-2\sqrt{2(5+\sqrt{5})} \operatorname{ArcTan}\left[\frac{1-\sqrt{5}+4x}{\sqrt{2(5+\sqrt{5})}}\right] - 2\sqrt{10-2\sqrt{5}} \operatorname{ArcTan}\left[\frac{1+\sqrt{5}+4x}{\sqrt{10-2\sqrt{5}}}\right] + 4\operatorname{Log}[-1+x] + (-1+\sqrt{5}) \operatorname{Log}\left[1-\frac{1}{2}(-1+\sqrt{5})x+x^2\right] - (1+\sqrt{5}) \operatorname{Log}\left[1+\frac{1}{2}(1+\sqrt{5})x+x^2\right] \right)$

input → In[2]:= Table[Sin[1.5 x]^2, {x, 0, 10}]

output → Out[2]= {0, 0.994996, 0.0199149, 0.955565, 0.078073, 0.879844, 0.169842, 0.773865, 0.28791, 0.646069, 0.422874}

input → In[3]:= Mean[%]

output → Out[3]= 0.475359

input → In[4]:= Plot3D[Sin[x+y^2], {x, -3, 3}, {y, -2, 2}]

output →

input → In[5]:= Factor[x^1000-1]

output → Out[5]= $(-1+x)(1+x)(1-x^2)(1-x^4)(1-x^8)(1-x^{16})(1-x^{32})(1-x^{64})(1-x^{128})(1-x^{256})(1-x^{512})(1-x^{1024})$

input → In[6]:= Grid[Table[Factor[x^n-1], {n, 10}, {n, 3}], Frame - All]

output →

1-x	1+x	1-x^2	1-x^4
1-x	1+x	1-x^2	1-x^4
1-x	1+x	1-x^2	1-x^4
1-x	1+x	1-x^2	1-x^4
1-x	1+x	1-x^2	1-x^4
1-x	1+x	1-x^2	1-x^4
1-x	1+x	1-x^2	1-x^4
1-x	1+x	1-x^2	1-x^4
1-x	1+x	1-x^2	1-x^4
1-x	1+x	1-x^2	1-x^4

input → In[7]:= Manipulate[Plot3D[Sin[x+y^2], {x, -n, n}, {y, -n, n}], {n, 1, 4}, {n, 1, 4}]

output →

Just a few functions take you a long way

Mathematica lets you create a complete interactive application in minutes

Make a plot

```
In[1]:= Plot[Sin[x] + Sin[10 x], {x, 0, 20}]
```

Out[1]=

```
In[2]:= Manipulate[Plot[Sin[x] + a Sin[10 x], {x, 0, 20}], {a, 0, 1}]
```

Out[2]=

Manipulable parameter

```
In[3]:= Manipulate[Plot[Sin[x] + a Sin[b x], {x, 0, 20}, PlotStyle -> color], {a, 0, 1}, {b, 0, 10}, {color, Red}]
```

Out[3]=

Add more controls

```
In[4]:= Manipulate[RevolutionPlot3D[Sin[x] + a Sin[b x], {x, 0, 20}, PlotStyle -> Opacity[.3, color], Axes -> False], {a, 0, 1}, {b, 0, 10}, {color, Red}]
```

Out[4]=

Every new function lets you go further

Mathematica can be used across all fields

The Wolfram Demonstrations Project™ includes thousands of interactive examples

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Algorithms, Computer Science ...
- Physical Sciences**
Physics, Earth Science ...
- Life Sciences**
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- Business and Social Systems**
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- Systems, Models, and Methods**
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- Mathematica Functionality**
Short Programs, 3D Graphics ...

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Full source code for output and interface

```
Manipulate[  
  With[  
    {u = Part[CellularAutomaton[{{m, (2, (2, 2, 2), (2, 1, 2), (2, 2, 2))}, (1, 1)},  
      {{Table[1, {init}]}}, 0], {t, All, All}},  
      1 - Accumulate[IntegerDigits[u, 2, t]]}],  
    With[  
      g = Graphics3D[{{Yellow, Sphere[{#2, #3, -#1]} & 000 Position[u, 1]},  
        PlotRange -> {{2 t + 3} (0, 1), {2 t + 3 + init} (0, 1), {-t - 1, 0}},  
        Method -> {"SpherePoints" -> {20, 15}}, ImageSize -> {600, 400},  
        Boxed -> False}],  
      Grid[{{g, Column[ArrayPlot[Sqrt[10 - Total[u]],  
        ImageSize -> 120, ColorFunction -> "SunsetColors"] & #  
        {u, Transpose[u], Transpose[u, {2, 3, 1}]]}}],  
      {{m, 164 124, "rule number"},  
        {{c, 121 268, 124 844, 124 826, 164 124, 174 826, 174 832}},  
        {{i, 784 951, "choice number"}, 1, 2*20, 1},  
        {{init, 25, "size of initial block"}, 2, 25, 1, Appearance -> "Labeled"},  
        {{t, 20, "steps of evolution"}, 1, 25, 1, Appearance -> "Labeled"}]
```

The Wolfram Demonstrations Project is a free resource of Mathematica material

Your data, or ours

Import data in any format

`In[1]= Import["satellites.xls", {"Data", 1}];`
`In[2]= DateListPlot[%][[All, {16, 14}]], FrameLabel -> %[[1, {16, 14}]]]`

Immediately analyze and visualize

Mathematica automatically imports and exports over 200 formats

`Text[Grid[Import["http://www.imdb.com/chart/", "Data"]][[1, 1, 1, 5]],`
`Frame -> All, Background -> LightBlue]`

Automatically extract data from web pages

CSV, XLS, GIF, JPEG, PDF, Maya, STL, WAV, SWF, MDB, HDF, DICOM, 3DS, AVI, FITS, HDF5, MIDI, SVG, USGS DEM, MOL, GenBank, SHP, HTML, XML, TeX, MBOX, RSS, ...

Use Wolfram Research's curated data

Built-in function
Real-time data

`In[1]= WeatherData["Chicago", "WindSpeed"]`
`Out[1]= 14.5`

Stored data, continually updated

Wolfram Research maintains, updates, and verifies hundreds of types of data

Chemical data Biological & genomic data Socioeconomic data
 Geographic data Physics data Current & historical financial data
 Mathematical data Linguistic data

All Wolfram Research data in Mathematica is immediately computable

The power of integration

All the functions of Mathematica are designed to work tightly together

Mathematica seamlessly integrates data, programs, documents, images, and much more...

Drag and drop an image into Mathematica

Use a Mathematica function directly on the image

Create a custom interface

`In[1]= Manipulate[Dilation[Image[Sunflower], r], {r, 0, 10}]`

`In[1]= images = Flatten[ImagePartition[Image[Clownfish], 40]]`
`Out[1]=`

Partition an image into a matrix

`In[10]= Graphics[Mean[Mean[ImageData[#]]][[1, 3]], Center, .05] & /@ images, Frame -> True]`

Arrange the subimages by color

`In[3]= data = Mean[Mean[ImageData[#]]] & /@ images;`
`nf = Nearest[data -> images];`
`In[5]= GraphPlot[Flatten[Table[Thread[images[[1]] -> nf[data[[1]], 3], {1, Length[images]}]], VertexRenderingFunction -> (Inset[#2, #, Center, .4] &), SelfLoopStyle -> None]`

Compute the network of neighbors in color space

The power of automation

Mathematica automatically finds the best way to do what you want

You specify the operation; Mathematica automatically determines the algorithm

```
In[1]:= s = NDSolve[{x'[t] == -y[t] - x[t]^2,
y'[t] == 2 x[t] - y[t]^3, x[0] == y[0] == 1},
{x, y}, {t, 20}];
In[2]:= ParametricPlot[Evaluate[{x[t], y[t]} /. s],
{t, 0, 20}]
```

Mathematica automatically handles natural math input

Mathematica picks algorithms for accuracy and efficiency

```
In[1]:= Table[GraphPlot[Table[i -> Mod[i^2, n], {i, n}], {n, 51, 100, 10}]
```

Every visual output is automatically optimized for clarity and aesthetics

Options allow arbitrarily detailed customization

Mathematica's algorithms automatically adapt to your computation

```
In[1]:= TraditionalForm[∫ 1/(x^5 - 1) dx]
Out[1]//TraditionalForm=
1/20 ((√5 - 1) log(x^2 - 1/2(√5 - 1)x + 1) -
(1 + √5) log(x^2 + 1/2(1 + √5)x + 1) + 4 log(x - 1) -
2√(2(5 + √5)) tan^-1((4x - √5 + 1)/√(2(5 + √5))) - 2√(10 - 2√5) tan^-1((4x + √5 + 1)/√(10 - 2√5)))
```

Mathematica completely automates expert-quality typesetting

```
In[1]:= NestList[Tan, 1.00000000000000000000000000000000, 40]
Out[1] := {1.00000000000000000000000000000000, 1.5574077246549022305069748075,
74.685933398765022668308000, -0.863518854878058881987016,
-1.169856355059865685415505, -2.35903773418889307931988,
0.9943296190037656445759, 1.5381535568576459424245,
⋮
0.7035836, 0.8484329, 1.134741, 2.146060, -1.54221, -34.97, -0.44,
-0.47, -0.51, -0.56, -0.6, -0.7, -0.9, -1.2, -2., 0. × 10^-1, 0. × 10^-1};
```

Mathematica automatically tracks and controls numerical precision

All displayed digits are verified correct

The power of the Mathematica notebook

Automatically organize everything in executable interactive formatted documents

Open to show section contents

Text

Graphics

Typeset math

Runnable code

Embedded interactivity

Cell brackets show document structure

Closed cell hides code

Include annotations

Edit and re-run code at any time

Everything in a notebook is immediately editable, interactive, and printable

Notebooks can include animation, sound, and other multimedia content



A notebook can be a ...



- Presentation
- Demonstration
- Palette
- Drawing canvas
- Automatic report
- Dialog or form
- Source editor
- Interactive application


The world's most productive programming language

Mathematica gives the power and flexibility of multiple integrated programming paradigms


Create any structure symbolically
 In[1]:= NestList[f, x, 5]
 Out[1]= {x, f[x], f[f[x]], f[f[f[x]]], f[f[f[f[x]]]], f[f[f[f[f[x]]]]}

Programmatically build interfaces
 In[2]:= NestList[TableView[#, #] &, Button[, 2], 2]
 Out[2]= 

Use symbolic patterns
 In[3]:= make3d[Graphics[g_, _], a_] := Graphics3D[g /. {x_, y_} -> {y, x, Sin[a π x] / Sqrt[x + 4 y]} /. Line[u_] -> Tube[u, 1/20]]
 In[4]:= Table[make3d[, k/3], {k, 4}], make3d[, 1/2]

Handle graphics directly in programs
 Out[4]= 

Transparently access real-world data
 In[5]:= If[FinancialData["MSFT", "Price"] < 10, SendMail[{"To" -> "x@y.com", "Body" -> "buy!"}]];

Give symbolic input
 In[6]:= LowestEnergy[ψ_, λ_, x_] := Module[{ε}, ε[ε_?NumberQ] := Abs[ψ[10]] /. First[NDSolve[{-ψ'[x] + λ ψ[x] == ε ψ[x], ψ[0] == 1, ψ'[0] == 0}, ψ, {x, 0, 10}]]; Last[FindMinimum[ε[ε], {ε, 1/2, 2}]]
 In[7]:= LowestEnergy[x^4 + 3 x^2, 1, x]
 Out[7]= {ε -> 1.93051}
 In[8]:= Rotate[Framed[Rasterize[SelectedNotebook[]]], 275 °]
 Out[8]= 

Get a symbolic form
Include anything in a program
Platform-independent system interaction
Use the full algorithmic power of Mathematica
Include math notation
Everything is symbolic—including programs and documents

Program in whatever style you want

f = Factorial

f[n_] := n!

Rule-based

f[n_] := n f[n - 1]; f[1] = 1

Procedural

f[n_] := Module[{t = 1}, Do[t = t * i, {i, n}]; t]

List-based

f[n_] := Apply[Times, Range[n]]

f[n_] := Fold[Times, 1, Range[n]]

Recursive

f[n_] := If[n == 1, 1, n * f[n - 1]]

Functional

f = If[#1 == 1, 1, #1 #0[#1 - 1]] &

f[n_] := Fold[#2[#1] &, 1, Array[Function[t, #t] &, n]]

Constructive

f[n_] := Length[Permutations[Range[n]]]

Pattern-based

f[n_] := First[{1, n} /. {a_, b_ /; b > 0} -> {b a, b - 1}]

String-based

f[n_] := StringLength[Fold[StringJoin[Table[#1, {#2}]] &, "A", Range[n]]]

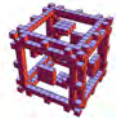
Mathematical

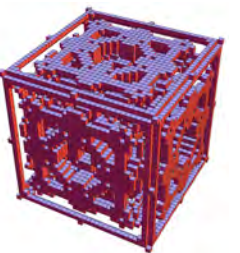
f[n_] := Gamma[n - 1]

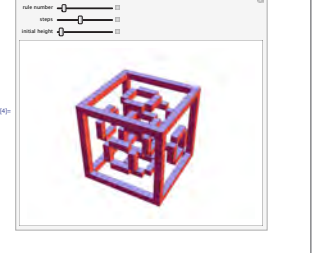
f[n_] := Product[i, {i, n}]

From a 10-second student question... to a million-line production software system


Mathematica is a completely scalable language and environment

Type one line to get a lot done instantly
 In[1]:= Graphics3D[Cuboid /@ Position[CellularAutomaton[{122, {2, 1}, {{1, 1}}, {{{1}}, 0}, {{{6}}}], 1]]
 Out[1]= 

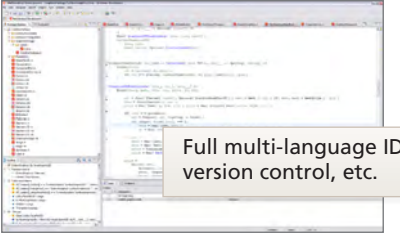
Do a larger computation
 In[2]:= Graphics3D[Cuboid /@ Position[CellularAutomaton[{122, {2, 1}, {1, 1, 1}}, {{{1}}, 0}, {{{16}}}], 1]]
 Out[2]= 

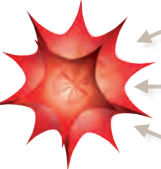
Seamlessly scale up to a program
 Manipulate[Graphics3D[EdgeForm[Opacity[.3]], Cuboid /@ Position[CellularAutomaton[rm, {2, 1}, {1, 1, 1}], {{Table[i, {i, 1}], 0}, {{{t}}, 1}], Boxed -> False, PlotRange -> All, PlotImagePadding -> 1, ImageSize -> {400, 300}, SphericalRegion -> True, ImageSize -> Small], {rm, 14, "rule number", 2, 200, 4, ImageSize -> Small}, {{t, 4, "steps"}, 0, 16, 1, ImageSize -> Small}, {{init, 1, "initial height"}, 1, 10, 1, ImageSize -> Small}]
 Out[0]= 

Immediately compute in parallel
 ParallelTable[...]
 Multicore configuration is automatic

Deploy to Mathematica Player™ to run outside Mathematica

 .nb .nbp

Mathematica has been used for two decades in the world's leading companies and universities

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Quickly look up selected text → **F1**

Complete typed commands and insert function templates → **control + shift + K** (Mac: command + shift + K)

Tree of topics (points to sidebar navigation)

Home page (points to Wolfram Mathematica Documentation Center header)

Guide page (topic overview/reference) (points to Calculus topic page)

Function home page (points to Integrate function page)

Function Navigator (points to F[...] icon)


Virtual Book (points to Virtual Book icon)

Immediately try or modify any example inline (points to code examples in the Integrate function page)


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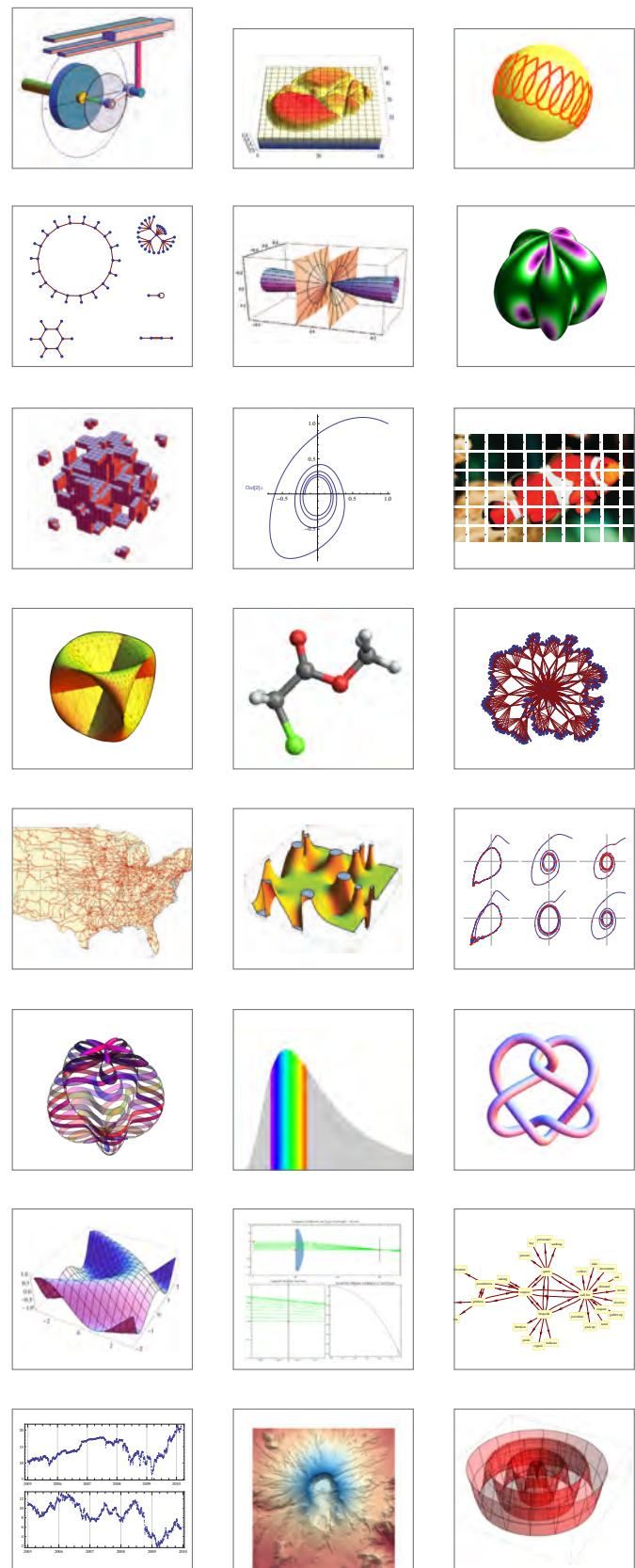
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