# Comparison of Graphics Capabilities between *Mathematica* 9 and Maple 16

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## Summary

As in many areas of functionality, apparent similarities in visualization capabilities between Maple and *Mathematica* are only skin deep.

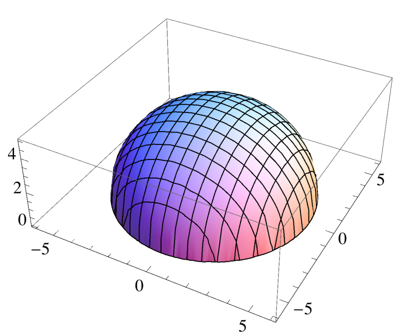
- *Mathematica* automates more of the graphic creation to give more accurate or more understandable results in more cases.
- *Mathematica* automates more sensible aesthetic choices for professional-looking results.
- *Mathematica* supports a wider range of visualization routines.
- *Mathematica* visualizations make use of dynamic elements for richer electronic presentation.
- *Mathematica* provides greater control over feature choices and content rendering.

## Surface Plots (3D)

Most *Mathematica* routines use adaptive resampling to achieve smooth results, even where functions are rapidly changing. Most Maple visualizations do not. Without it, Maple is unable to trace the smooth circular perimeter of this plot.

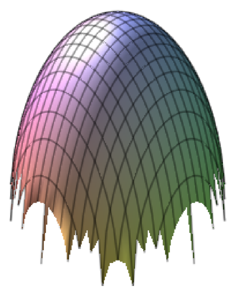
**Plot3D**$\left[\sqrt{25 - x^2 - y^2}, \{x, -6, 6\}, \{y, -6, 6\}\right]$

***Mathematica***



**Maple**

$plot3d\left(\sqrt{25 - x^2 - y^2}, x=-6..6, y=-6..6\right)$



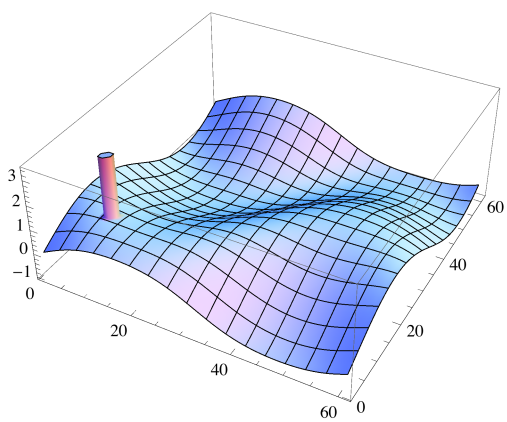
Notice also that the *Mathematica* 3D images are rendered using perspective. Maple's use no perspective and appear as if viewed from an infinite distance, giving a slightly unnatural look.

The default choice for Maple is not to include axes for either scale or orientation, which can make plots hard to interpret unless the user manually adds them.

Maple can only automate sensible plot ranges for data with outliers in 2D. In this 3D example, a table of values is generated for a curved surface with one strong outlier. *Mathematica*'s automatic plot range preserves most of the interesting detail in the image at the expense of the outlier.

***Mathematica***

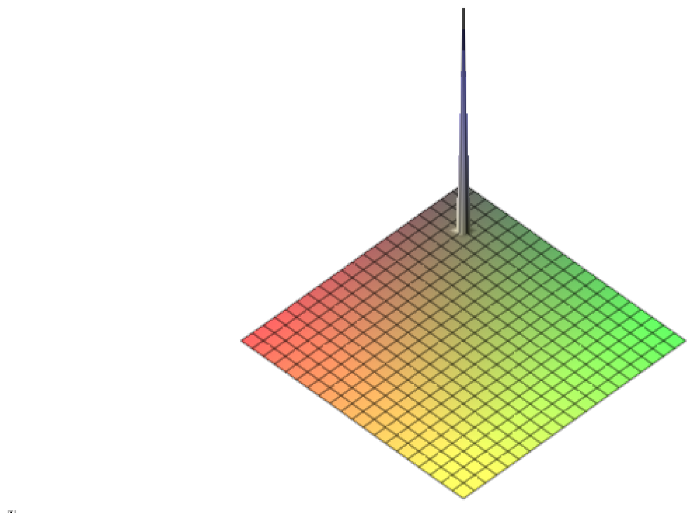
```
data = Table[Sin[x + Sin[y]], {x, 0, 6, 0.1}, {y, 0, 6, 0.1}];
data[[10, 10]] = 1000;
ListPlot3D[data]
```




However, all useful detail in the Maple plot is lost in order to include the single outlier.

### Maple

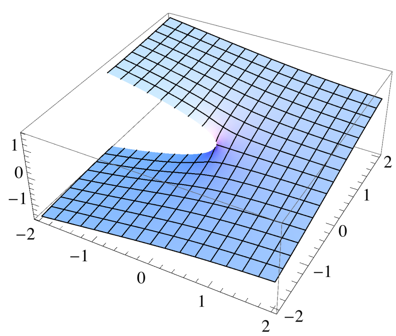
$with(plots) : matrixplot(data)$



*Mathematica* automatically detects many kinds of branch cuts and discontinuities in function plots.

### *Mathematica*

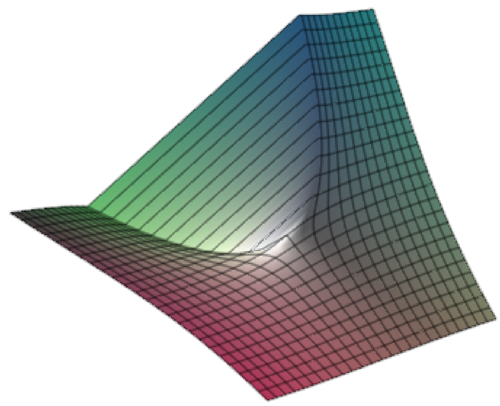
**Plot3D[Im[$\sqrt{x + I\, y}$], {x, -2, 2}, {y, -2, 2}]**




Maple incorrectly joins up the branch cut to make the function appear continuous.

**Maple**

$plot3d(\mathrm{Im}(\mathrm{sqrt}(x + I \cdot y)), x = -2..2, y = -2..2)$



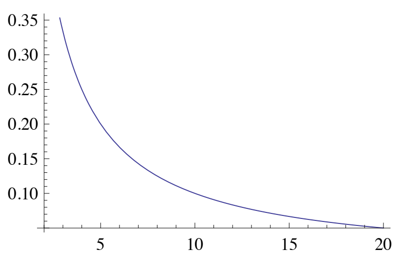
**Note:** the output of the Maple plot has been manually rotated, as the default viewpoint obscured the key feature.

# Function Plots (2D)

For standard 2D plots, Maple uses an aspect ratio of 1:1, compared to the more natural golden ratio used by *Mathematica*.

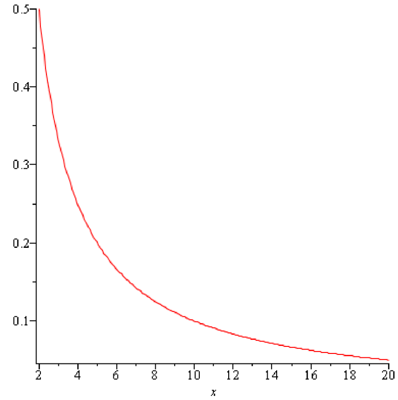
***Mathematica***

$\mathbf{Plot}\left[\frac{1}{x}, \{x, 2, 20\}\right]$



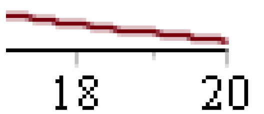
### Maple

$plot\left(\frac{1}{x}, x = 2..20\right)$

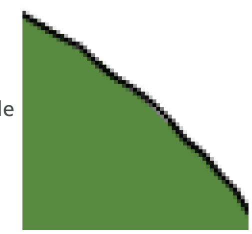
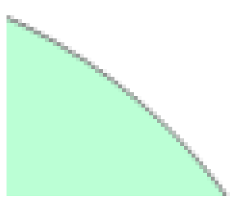



Maple uses very light antialiasing on lines and no antialiasing at all on the tick marks. This results in a more jagged screen appearance, despite the choice of a larger font size.

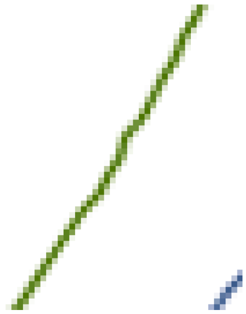
*Mathematica* at 200%: 


Maple at 200%: 

.

This becomes more significant in areas of curvature. For example, a detail from the edge of a pie chart (created at default size and shown at 200% here) reveals significant irregularity in Maple  when compared to a similar detail from *Mathematica* .

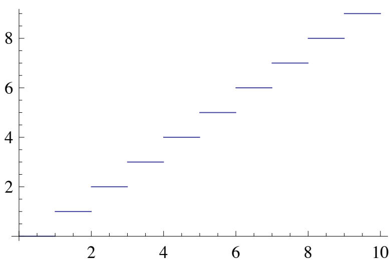
Even examples used in MapleSoft's own marketing pages show these kinds of antialiasing irregularities. This detail is shown at 300%:



*Mathematica* automatically detects many kinds of branch cuts and discontinuities.

### *Mathematica*

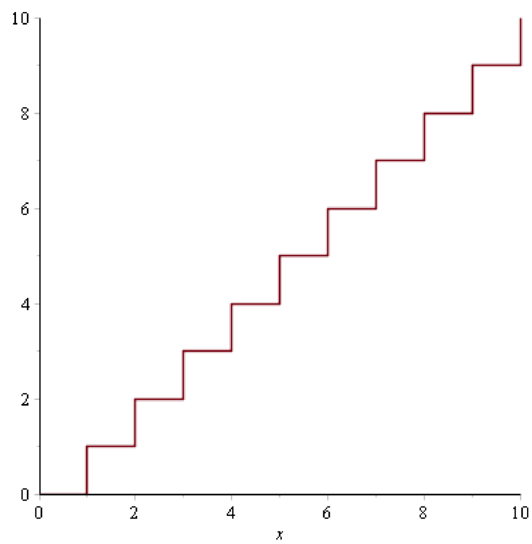
```
Plot[Floor[x], {x, 0, 10}]
```




Maple incorrectly implies that there is a value of floor($x$) = $\frac{1}{2}$.

### Maple

*plot*(floor($x$), $x$ = 0 ..10)

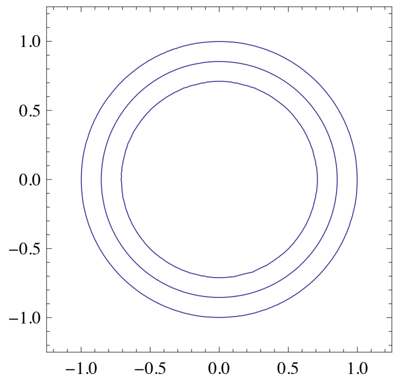


# Implicit Plotting and Contour Plotting

In implicit plotting and contour plotting, Maple's lack of automatic adaptive resampling results in poor smoothness.

### *Mathematica*

```
ContourPlot[(x^2 + y^2 - 1) (x^2 + y^2 - 0.73) (x^2 + y^2 - 0.5) == 0,
 {x, -1.2, 1.2}, {y, -1.2, 1.2}]
```

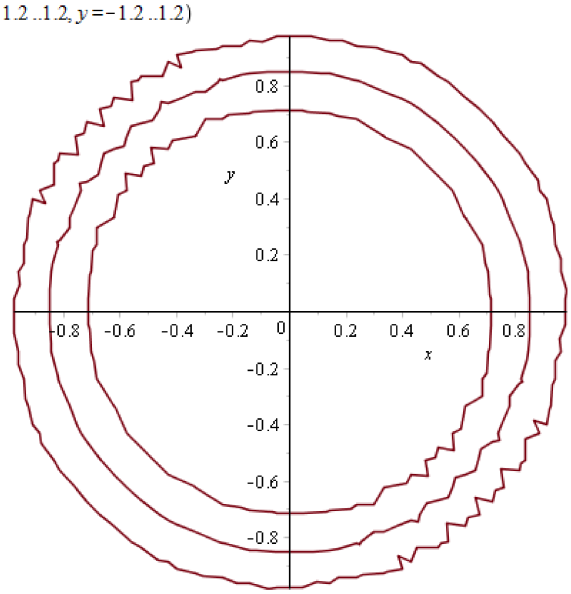



### Maple

*with*(*plots*, *implicitplot*) :

$fn := (x^2 + y^2 - 1) \cdot (x^2 + y^2 - 0.73) \cdot (x^2 + y^2 - 0.5)$ :

*implicitplot*(*fn*, *x* = −1.2 ..1.2, *y* = −1.2 ..1.2)

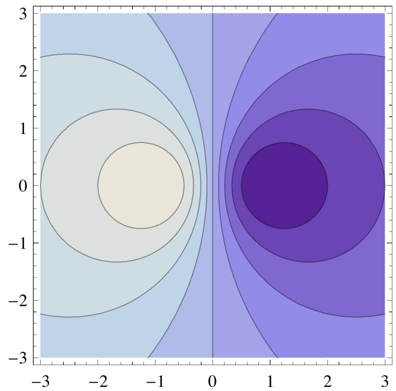



If you are reading this in CDF format, you will notice that lines in `ContourPlot` have mouseover tooltips to give the contour values or equations. Maple does not provide interactive content in any of its plots.

In the following example, notice how the only indication of relative contour values in Maple is the subtle color differences on the thin contour lines. The color filling between contours in Mathematica is easier to perceive, and the tooltips allow the user to see specific contour values. Again, poor antialiasing in Maple makes lines appear less smooth than in Mathematica.

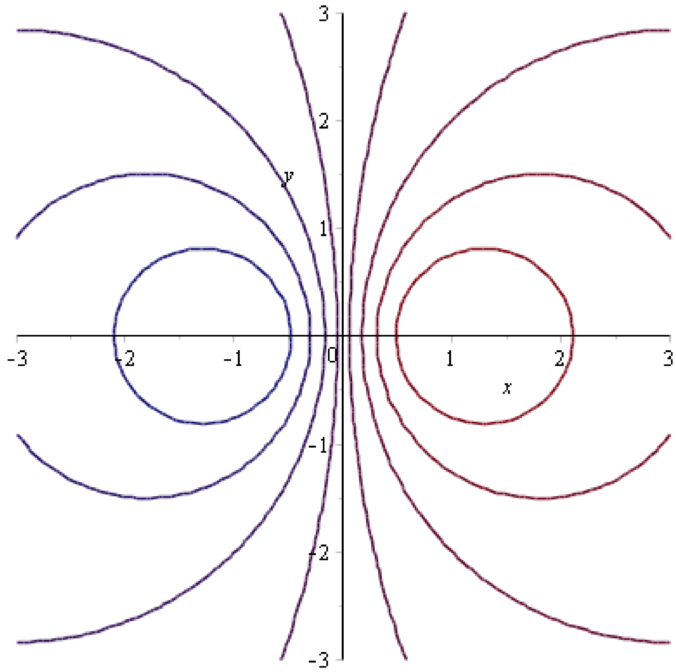
*Mathematica*

$$\texttt{ContourPlot}\left[-\frac{5\,x}{x^2+y^2+1},\ \{x,-3,3\},\ \{y,-3,3\}\right]$$




**Maple**

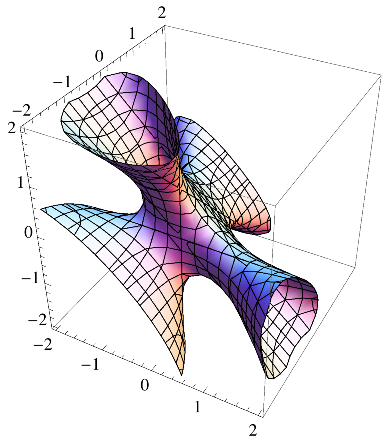
$$with(plots) : contourplot\left(-\frac{5\,x}{x^2+y^2+1}, x=-3\,..3, y=-3\,..3\right)$$




In 3D contour plotting, Maple's lack of adaptive sampling combined with a low sample rate yields extremely rough results. Again, the default lack of axes in Maple makes interpretation difficult.

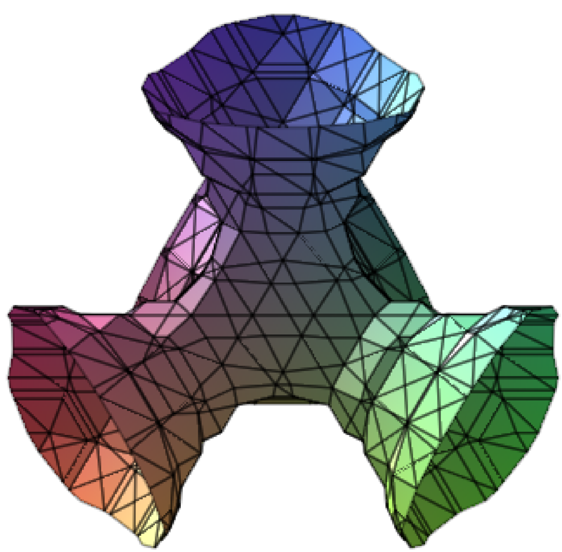
***Mathematica***

```
ContourPlot3D[x^3 + y^3 + z^3 + 1 == (x + y + z + 1)^3, {x, -2, 2}, {y, -2, 2}, {z, -2, 2}]
```




**Maple**

$implicitplot3d(x^3 + y^3 + z^3 + 1 = (x + y + z + 1)^3, x = -2..2, y = -2..2, z = -2..2)$



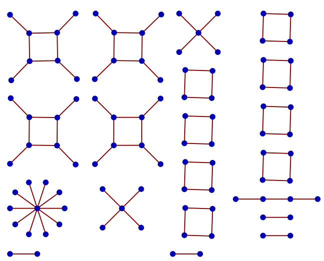
# Graph Plotting

Maple provides graph plotting, but based on much more primitive algorithms. In this example, notice how *Mathematica* manages to avoid any edge crossings and has managed to use the canvas area more evenly. The Maple plot of the same data is confusing. This is made worse by the default choice of Maple to label vertices. This fairly small set of data is already too large to fit all vertex labels without overlaps making them unreadable. Instead, *Mathematica* has provided mouseover tooltips to label vertices by default. Maple is unable to produce any graph if the graph contains a self-connected vertex.

*Mathematica*

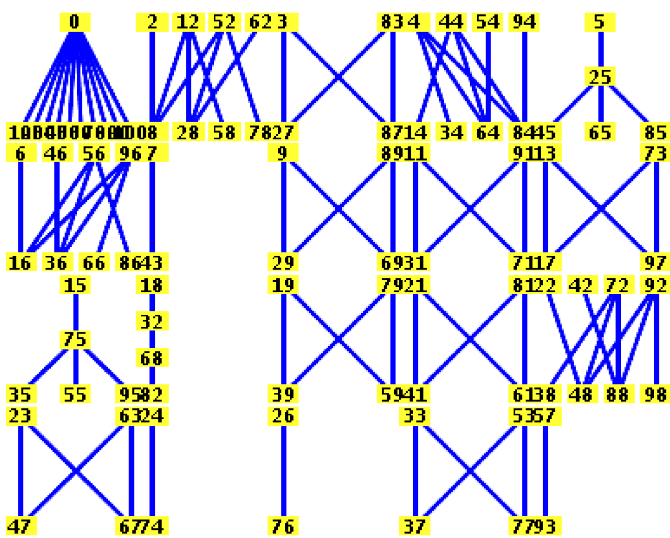
```
network = {0 → 10, 0 → 20, 0 → 30, 0 → 40, 0 → 50, 0 → 60, 0 → 70, 0 → 80, 0 → 90, 0 → 100,
    2 → 8, 3 → 27, 3 → 87, 4 → 34, 4 → 64, 4 → 84, 5 → 25, 6 → 16, 7 → 43, 8 → 12, 8 → 52,
    9 → 29, 9 → 69, 11 → 31, 11 → 71, 12 → 28, 12 → 58, 13 → 17, 13 → 97, 14 → 44, 15 → 75,
    16 → 56, 16 → 96, 17 → 73, 18 → 32, 19 → 39, 19 → 59, 21 → 41, 21 → 61, 22 → 48, 23 → 47,
    23 → 67, 24 → 74, 25 → 45, 25 → 65, 25 → 85, 26 → 76, 27 → 83, 28 → 52, 28 → 62, 29 → 89,
    31 → 91, 32 → 68, 33 → 37, 33 → 77, 35 → 75, 36 → 46, 36 → 56, 36 → 96, 37 → 53, 38 → 72,
    39 → 79, 41 → 81, 42 → 88, 44 → 64, 44 → 84, 47 → 63, 48 → 72, 48 → 92, 52 → 78, 53 → 77,
    54 → 64, 55 → 75, 56 → 86, 57 → 93, 59 → 79, 61 → 81, 63 → 67, 66 → 96, 68 → 82,
    69 → 89, 71 → 91, 72 → 88, 73 → 97, 75 → 95, 83 → 87, 84 → 94, 88 → 92, 92 → 98};

GraphPlot[network]
```



Maple

*with*(*GraphTheory*) : *DrawGraph*(*network*)



## Statistical Charts

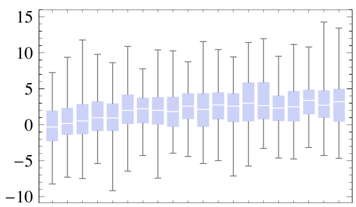
Both *Mathematica* and Maple provide standard statistical charts, but in this example Maple's choice to use many of the same defaults as a function plot (1:1 aspect ratio, *x* axis inside the image) makes the image harder to interpret, since *x* axis tick labels appear on top of key features. *Mathematica* uses mouseover tooltips to convey additional information in most graphics types. In this case, mousing over the last dataset shows the following information.

| | |
|---|---|
| **max** | 13.4124 |
| **75%** | 4.99292 |
| **median** | 3.22043 |
| **25%** | 0.39816 |
| **min** | −4.65948 |

Maple does not use tooltips in any graphics. The graduated color scheme used by Maple has no meaning and is there only for questionable aesthetic appeal.

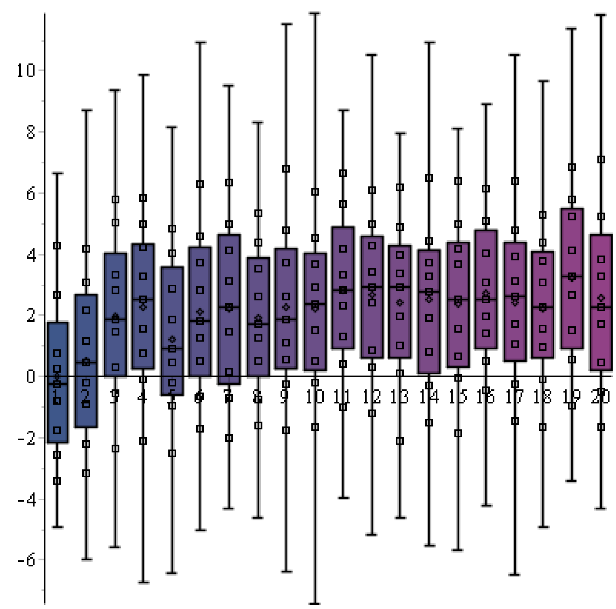
### *Mathematica*

```
BoxWhiskerChart[Table[RandomVariate[NormalDistribution[Log[i], 3], 100], {i, 20}]]
```




### Maple

```
with(Statistics) :
A := [seq(Sample(Normal(ln(i), 3), 100), i = 1 ..20)] :
BoxPlot(A)
```

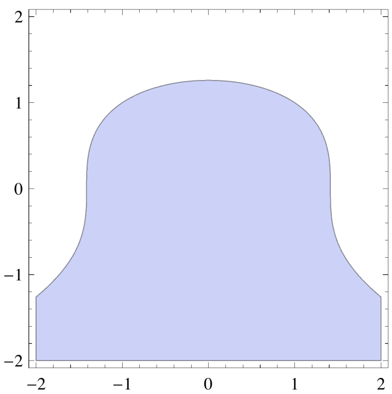


# Inequality Plotting

Maple provides an inequality plotting function, but it handles only the most trivial case of straight line inequalities.

### *Mathematica*

```
RegionPlot[x^2 + y^3 < 2, {x, -2, 2}, {y, -2, 2}]
```



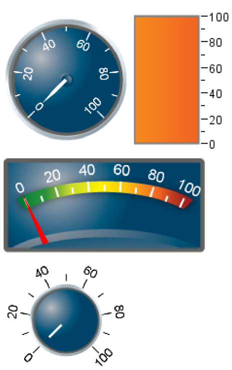
### Maple

$inequal(x^2 + y^3 < 2, x=-2..2, y=-2..2)$

```
Error, (in plots/inequal) the inequalities should be linear in `x` and `y`
```

# Dials and Gauges

While Maple supports dials and gauges, their implementation is typically shallow. While their values can be updated programmatically, they cannot be created programmatically (instead they must be placed manually by point and click). There is no customization of their appearance, except for tick mark placement, so only the four choices shown below are allowed and only in these colors.

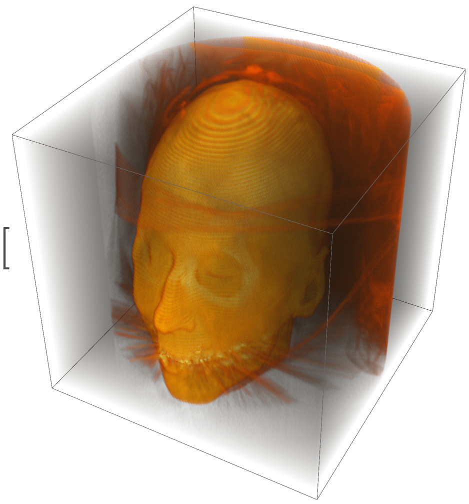


In contrast, *Mathematica* contains a large collection of built-in styles, and full control over shape, appearance, and labels. Following is a small sample of possibilities.

## Images

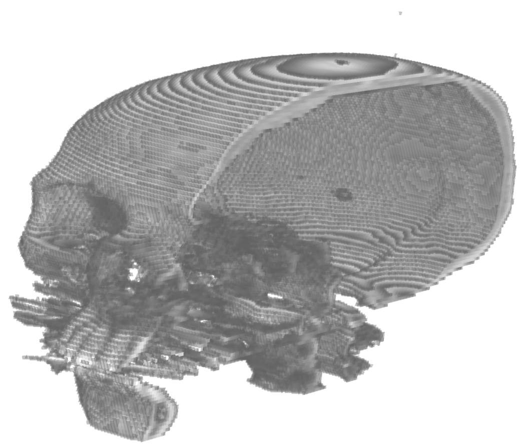
While Maple does contain some rudimentary image processing tools, it is incapable of displaying an image as a result, alongside other results. It can only display an image in a temporary window of its own, which cannot be controlled in any way or saved. Strangely, an image can be written to a file, from which the user can manually insert it back into the worksheet, using menus and a file browser. Maple cannot process or display 3D images in any way. In contrast, *Mathematica* can return 2D and 3D images just like any other result, and use them as input directly within the code.

**ImageTake[Image3D[**



**,**

**ColorFunction → "HighRange"], All, All, {1, 120}]**

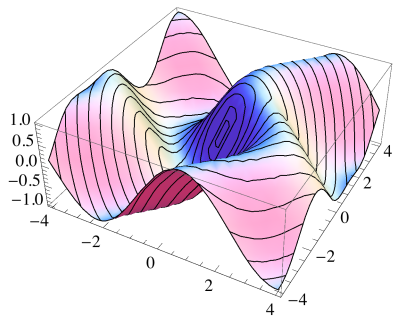


# Additional Content Controls

## Meshes

Most *Mathematica* 3D visualization routines give optional arbitrary control over mesh lines. Maple provides only rectangular mesh lines or contours.

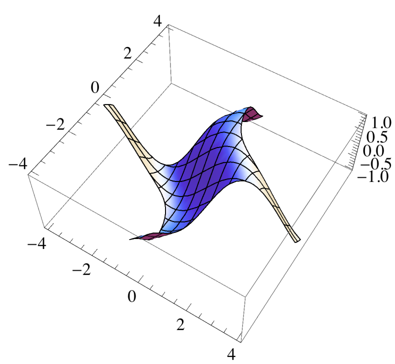
```
Plot3D[Sin[x + Sin[y]], {x, -4, 4}, {y, -4, 4}, MeshFunctions → (√(#1² + #2² + #3²) &)]
```




## Regions

Many *Mathematica* visualization routines provide optional arbitrary plot region control. Adaptive resampling ensures that the regions are smoothly rendered. Maple has no equivalent functionality.

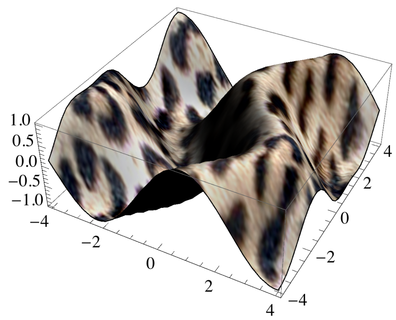
```
Plot3D[Sin[x + Sin[y]], {x, -4, 4}, {y, -4, 4}, RegionFunction → (-1 < #1 #2 < 1 &)]
```



## Textures

As well as providing richer control over surface lighting models, *Mathematica* also provides arbitrary texture mapping for surfaces, which Maple does not.

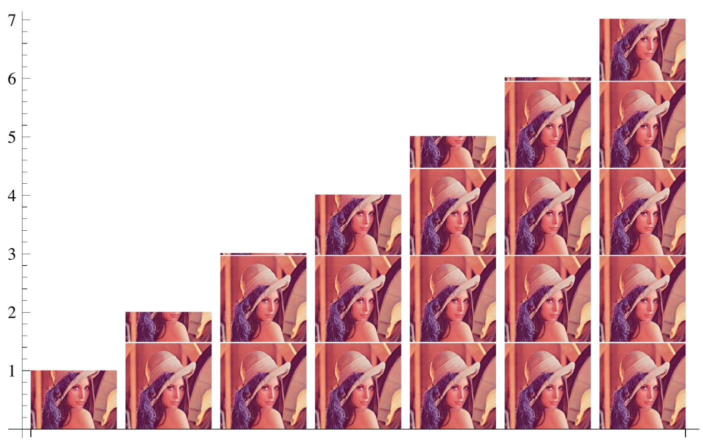
```
Plot3D[Sin[x + Sin[y]], {x, -4, 4}, {y, -4, 4}, Mesh → False,
 Lighting → {{"Directional", White, {{1, 0, 1}, {0, 0, 0}}}},
 PlotStyle → Texture[ExampleData[{"ColorTexture", "CheetahFur"}]]]
```



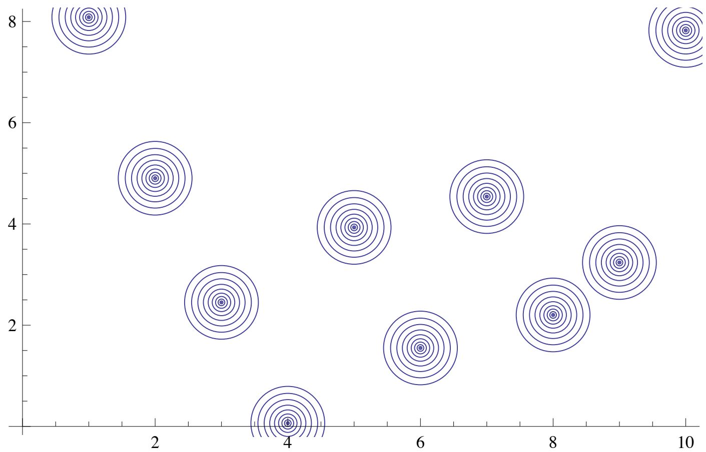

## Chart Elements

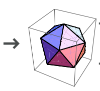
- Similarly, charts can often take arbitrary chart elements. In Maple, only fixed choices are available.

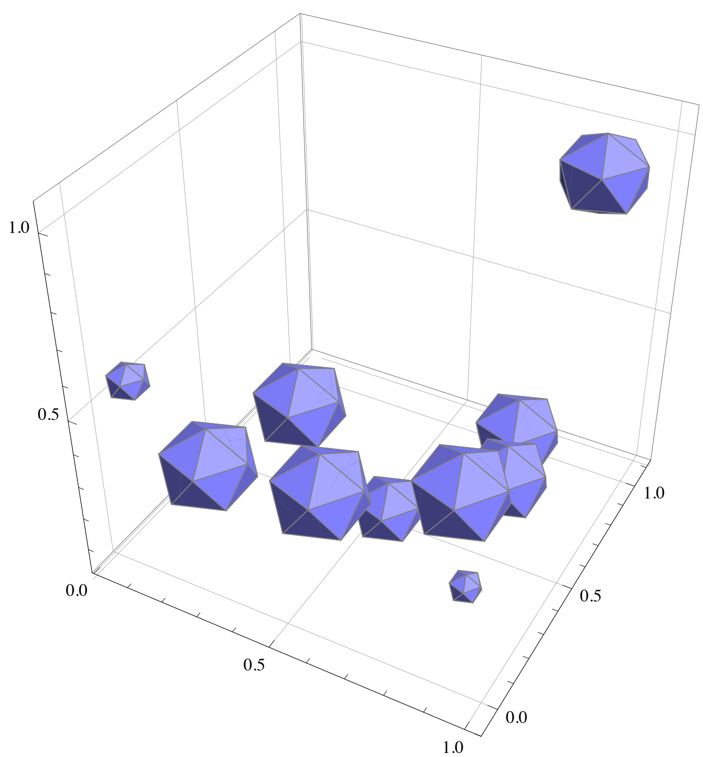
```
BarChart[Range[7], ChartElements -> ExampleData[{"TestImage", "Lena"}]]
```



```
ListPlot[RandomReal[10, 10],
 PlotMarkers → Graphics[Table[Circle[{0, 0}, r^2], {r, 10}], ImageSize → 40]]
```



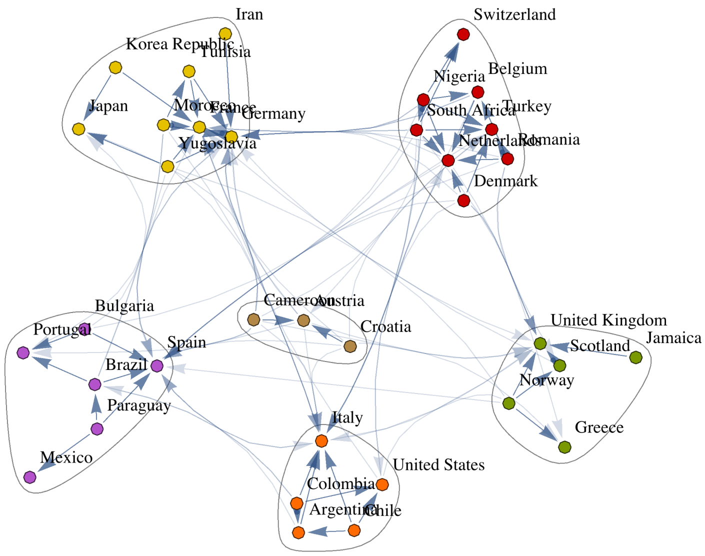

**BubbleChart3D[RandomReal[1, {10, 4}], ChartElements →**  **]**



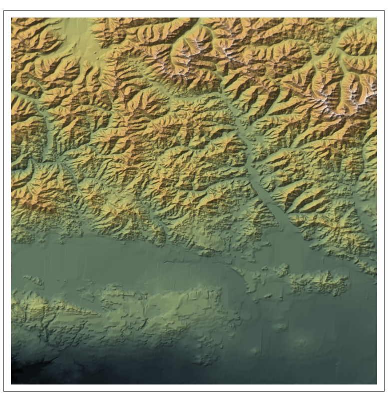
## Visualization Routines Missing from Maple

Maple has no direct way to produce any of the following visualization types.

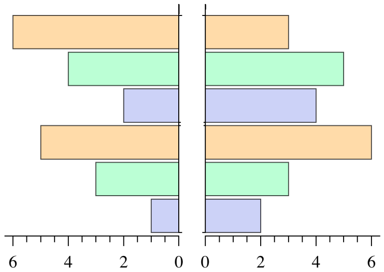
```
CommunityGraphPlot[ExampleData[{"NetworkGraph", "WorldCup1988"}]]
```



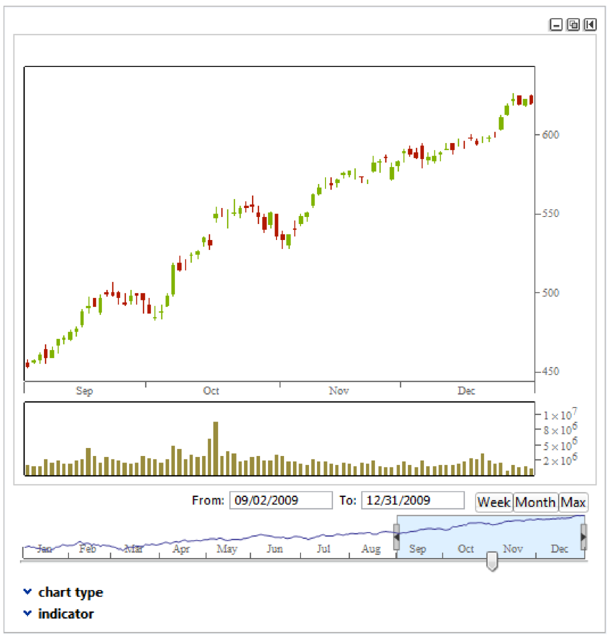

```
ReliefPlot[Import["http://exampledata.wolfram.com/hailey.dem.gz", "Data"],
 ColorFunction → "GreenBrownTerrain"]
```



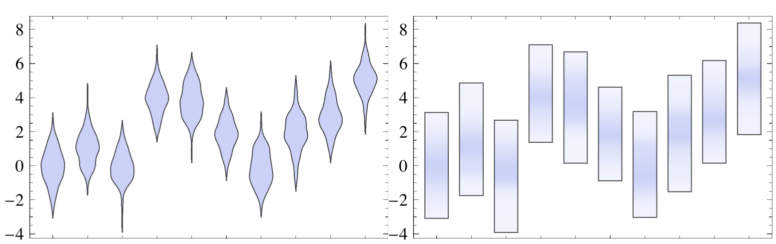
```
PairedBarChart[{{1, 3, 5}, {2, 4, 6}}, {{2, 3, 6}, {4, 5, 3}}]
```

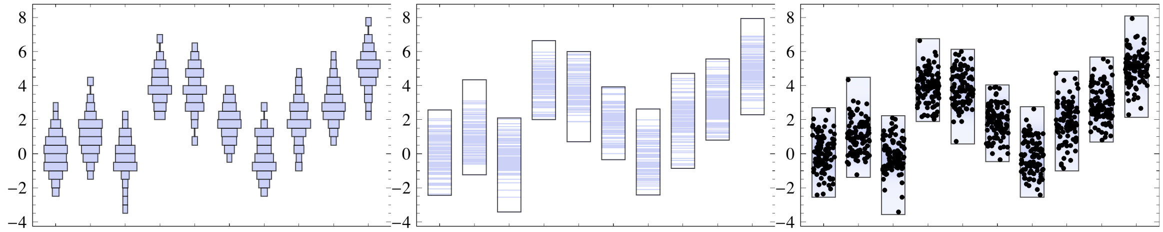


```
InteractiveTradingChart[{"GOOG", {{2009, 1, 1}, {2009, 12, 31}}}]
```

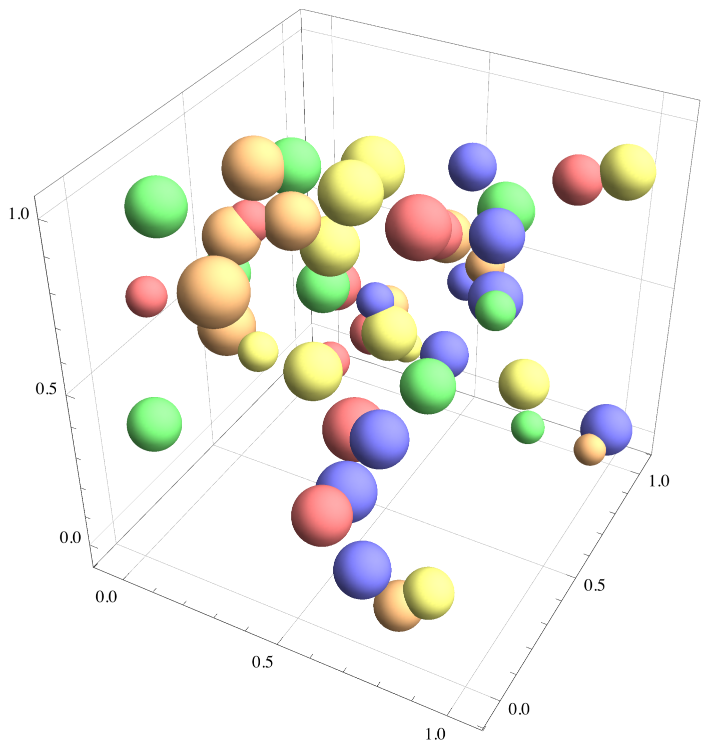



```
data = Table[RandomVariate[NormalDistribution[RandomInteger[5], 1], 100], {10}];
Row@Table[DistributionChart[data, ChartElementFunction → f, ImageSize → 200],
  {f, {"SmoothDensity", "Density",
    "HistogramDensity", "LineDensity", "PointDensity"}}]
```

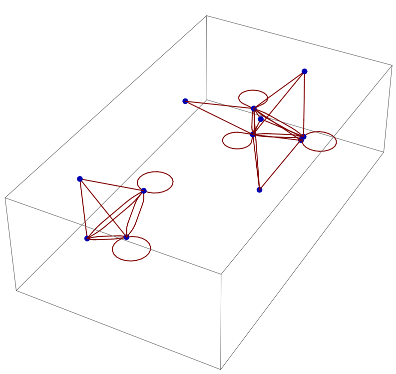




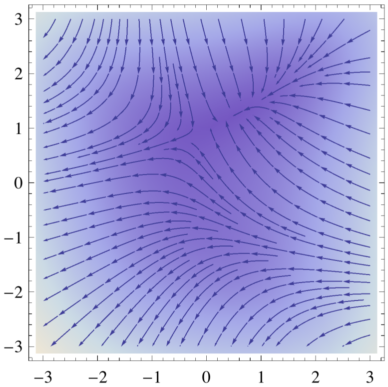

```
BubbleChart3D[RandomReal[1, {5, 10, 4}]]
```




```
GraphPlot3D[Union@Table[Mod[i^2, 15] → Mod[i, 12], {i, 50}]]
```

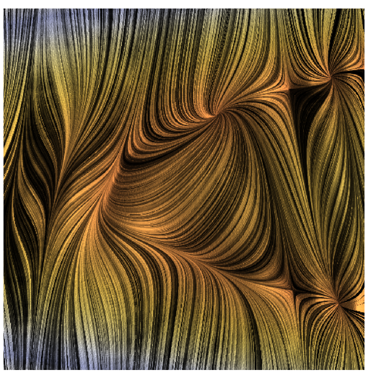


Line integral convolution plots.




Line integral convolution plots.

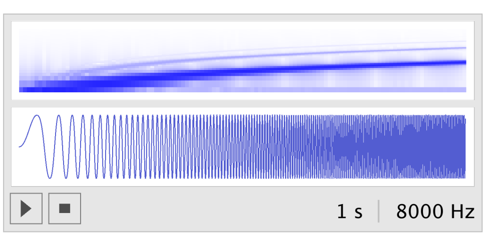
```
LineIntegralConvolutionPlot[{{Cos[x^2 + y], 1 + x - y^2}, {"noise", 500, 500}},
 {x, -3, 3}, {y, -3, 3}, ColorFunction → "BeachColors",
 LightingAngle → 0, LineIntegralConvolutionScale → 3, Frame → False]
```



## Sonification

Maple provides no facility for rendering data or functions as sound within a report. *Mathematica* documents can contain generated waveform sounds or MIDI instrumental sounds.

```
Play[Sin[Sin[1000 x^2]], {x, 0, 1}]
```



# Notes

- Images have been copied from Maple 16 using Windows Snipping Tool to preserve pixel-level screen rendering. Printing this document will not represent the resolution that printing from the original application would achieve.
- Except where stated, all comparisons use default options. Both systems allow manual control over plot details and in some cases, with sufficient work, a user may override some of the Maple deficiencies described in this comparison.