

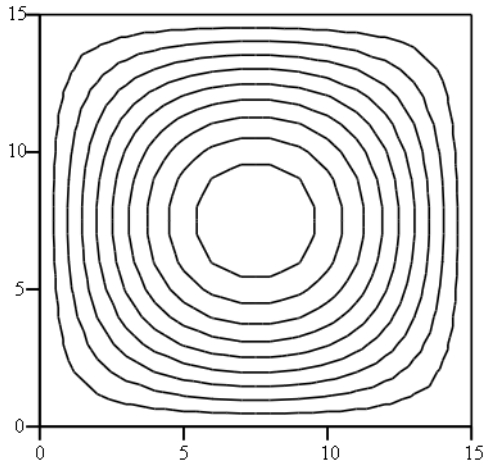
Plotting matrices, vectors and bitmaps

Contour plots

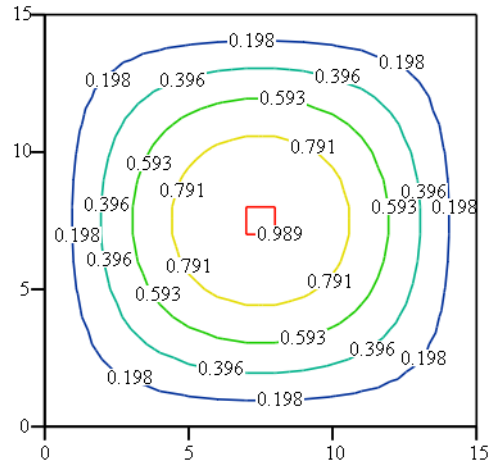
To illustrate contour plots we will use a 16 x 16 matrix with sinusoidal variation.

$$i := 0..15 \quad j := 0..15 \quad P2_{i,j} := \sin\left(\frac{\pi \cdot i}{15}\right) \cdot \sin\left(\frac{\pi \cdot j}{15}\right)$$

At left is the generic contour plot. The axes are labelled by grid point number. In the plot on the right, the popup box has been used to alter the default plot. Under the *Special* tab, the number of contours has been changed to 4 and the contour numbering option has been selected. Under the *Appearance* tab, *colormap* has been selected. The contours can also be filled with color to create a bullseye.



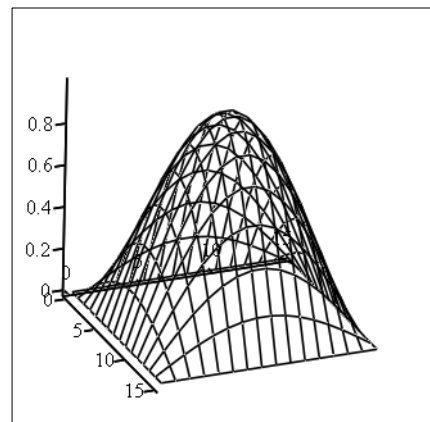
P2



P2

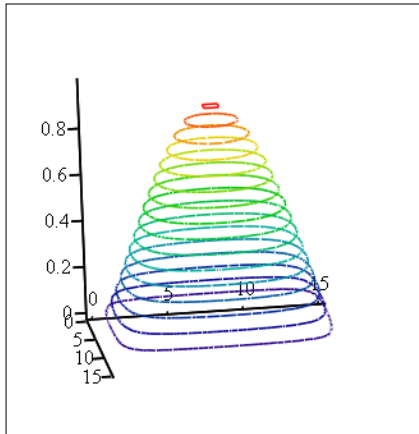
Surface plots

At right is the generic surface plot.

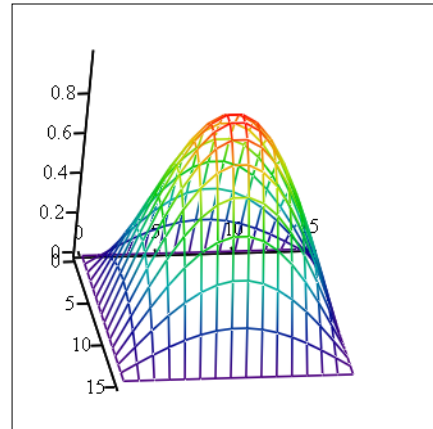


P2

In the plot at left below the plot type is *surface* (*general* tab) but the *contour* line option has been selected (*appearance* tab). In the plot at right below, *surface* plot is selected (*general* tab) and *wireframe* is selected (*appearance* tab).

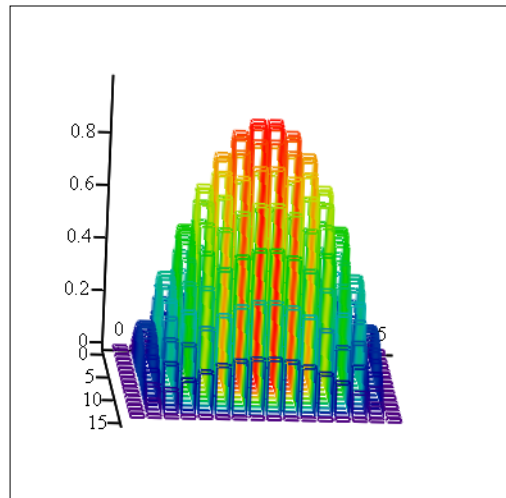


P2



P2

Another alternative is the 2-d histogram shown at right. This type of plot is most effective when the matrix has only a few rows and columns. The plot should be rotated so that the taller bars are in the background, if possible.



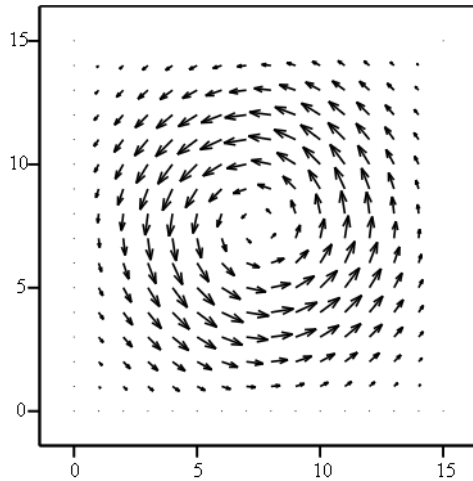
P2

Vector field plot

Define two matrices, having the values of the x and y components of the vectors evaluated on evenly spaced grid points in the x and y plane.

$$Xcomponents_{i,j} := \sin\left(\frac{1\pi \cdot i}{15}\right) \cdot \sin\left(\frac{2\pi \cdot j}{15}\right)$$

$$Ycomponents_{i,j} := -\sin\left(\frac{2\pi \cdot i}{15}\right) \cdot \sin\left(\frac{1\pi \cdot j}{15}\right)$$



(Xcomponents, Ycomponents)

Select the **vector field plot** from the Graph Toolbar and place the matrices within parentheses in the placeholder. The parentheses are essential for the plot to appear correctly. The longest vector will be scaled automatically to be equal to the grid spacing.

Picture

A matrix can be plotted as a picture, with the values indicating the level of brightness of the pixels. A gray scale of 0 to 255 is used. **Picture** is selected from the matrix toolbar.

$i := 0..99$ $j := 0..199$ We will create a 100 x 200 matrix.

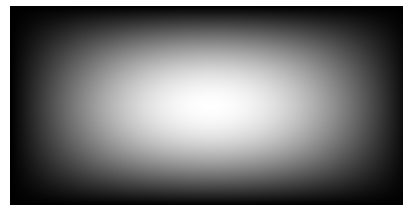
$$P_{i,j} := \sin\left(\frac{\pi \cdot i}{99}\right) \cdot \sin\left(\frac{\pi \cdot j}{199}\right)$$

The values in P vary sinusoidally.

$$P := \frac{P - \min(P)}{\max(P) - \min(P)} \cdot 255$$

Scale the matrix so the maximum value is defined as 255 (white) and the minimum value is defined as 0 (black).

In this picture, which is 100 pixels high by 200 pixels wide, 0 is black and 255 is white.



P

Color picture

Choose picture from the matrix menu.

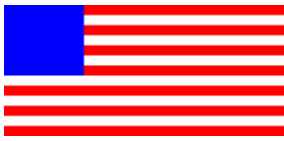
Three matrices, R, G and B, are used to assign the amount of red, green and blue.

$ii := 0..64$ $jj := 0..140$ Defines a matrix with 65 rows and 141 columns

$R_{ii,jj} := \text{if}(ii < 35 \wedge jj < 40, 0, 255)$ If we are in the upper left corner ($ii < 35$ and $jj < 40$), then no red. Red is needed to make both the red stripes and the white stripes. So red is needed everywhere else. White is red + blue + green.

$B_{ii,jj} := \text{if}[\text{mod}(ii, 10) \geq 5 \vee (jj < 40 \wedge ii < 35), 255, 0]$ Blue is needed if we are in a white stripe OR inside the upper left corner.

$G_{ii,jj} := \text{if}[\text{mod}(ii, 10) \geq 5 \wedge \neg(jj < 40 \wedge ii < 35), 255, 0]$ Green is needed if we are in a white stripe AND NOT inside the upper left corner.



R, G, B

The function $\text{mod}(ii, 10) \geq 5$, used to define the stripes, returns the remainder after division of ii by 10. In each 10 rows of pixels, the first five have blue and green off so only red appears, and the second five have blue and green on to make white, except in the blue patch at the upper left, where all colors are off but blue.

To enter the Boolean functions that are not on the keyboard, open the Boolean toolbar.