Exercise 4
Scientific Data Visualization
CSCE 5320 – Spring 2021
Distributed: Sunday, March 14
Due: Thursday, April 1

[Solutions to this assignment must be submitted via CANVAS prior to midnight on the due date. Submissions no more than one day late will not be penalized. Submissions up to one week late will be penalized 10 points. Submissions more than week late and less than two weeks late will be penalized 20 points. Submissions will not be accepted after the two weeks following the due date. [THIS IS AN INDIVIDUAL ASSIGNMENT]

Purpose: To practice measures over vector fields and the visualization of them via hedgehog plots and color maps.

What to do: Once again we will work with measures obtained from the two-variable Gaussian functional $z = f(x, y) = e^{-(x^2+y^2)}$. A vector field is necessary so the visualizations will be performed over the gradient vectors of the Gaussian functional.

Assume you know the ranges of interest [x_{min},x_{max}] and [y_{min},y_{max}] of the two independent variables. Consider the range *X=[-1x1]* and *Y=[-1x1]* which is divided into a grid density of your choice. Our visualizations will involve the gradient, divergence, and vorticity measures from those in the table below. Each vector field plot will be over a 2D grid on a white background.

Vector Field	Definition
Gradient	$\nabla f = \left(\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}\right) = (2xf, 2yf)$
Normal	$\mathbf{n} = -\nabla f = \mathbf{div}\left(-\frac{\partial f}{\partial x}, -\frac{\partial f}{\partial y}\right) = (-2xf, -2yf)$
Divergence	$\mathbf{div\ v} = \mathbf{div}\,\nabla f = \mathbf{div}\left(\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}\right) = \frac{\partial(2xf)}{\partial x} + \frac{\partial(2yf)}{\partial y}$
Vorticity	$\mathbf{rot\ v} = \mathbf{rot}\,\nabla f = \mathbf{rot}\left(\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}\right) = \frac{\partial(2yf)}{\partial x} - \frac{\partial(2xf)}{\partial y}$

The to-be-handed-in table (below) is sufficient to explain what else to do.

Item #	Measure	Description
1	*f(x,y)*	An elevation plot of the Gaussian functional. This is the only 3D visualization of this set of plots.
2	Gradient	A hedgehog plot of the gradient vector field. The glyph used and grid density is up to you.
3	Divergence	A hedgehog plot for which the gradient vector field is the **div** argument. That is, the orientation of each **div** vector is the same as the gradient vector while the magnitude is the divergence scalar. (Note that the divergence scalar can be negative.)

4	Vorticity	A hedgehog plot for which the gradient vector field is the argument. That is, for the purpose of this assignment, the orientation of the vector is the same as the gradient vector while the magnitude is the computed vorticity's k-component. (Note that the k-component can be negative.)
5	Divergence	A vector color coding of divergence for which the direction is the gradient. This will be an orientation only color coding. (See Fig. 6.10b.) Make the illumination (V value of HSV) and saturation value high enough to clearly see the colors.

Item 6 to be handed in is the code. For this assignment, there is no discussion of results required.

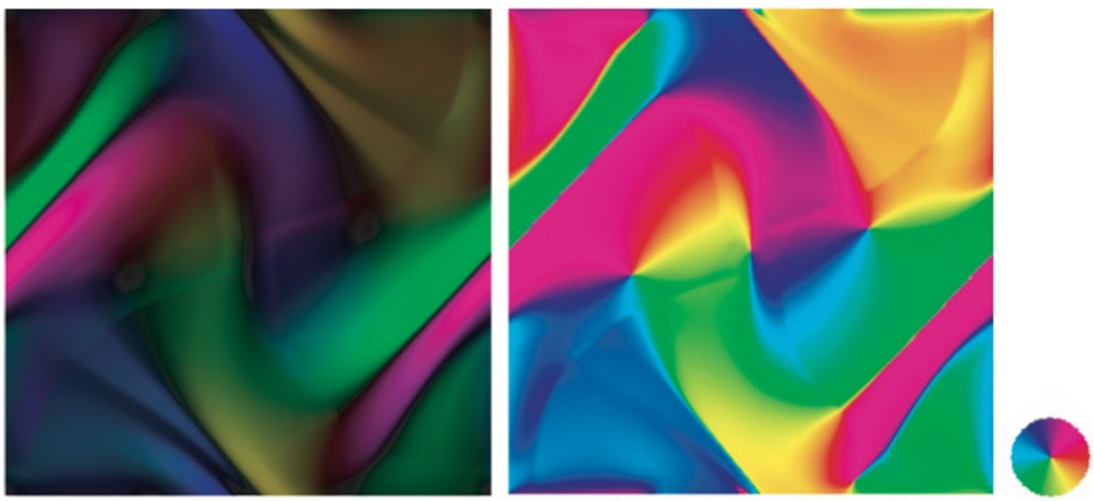

Figure 6.10 from textbook.