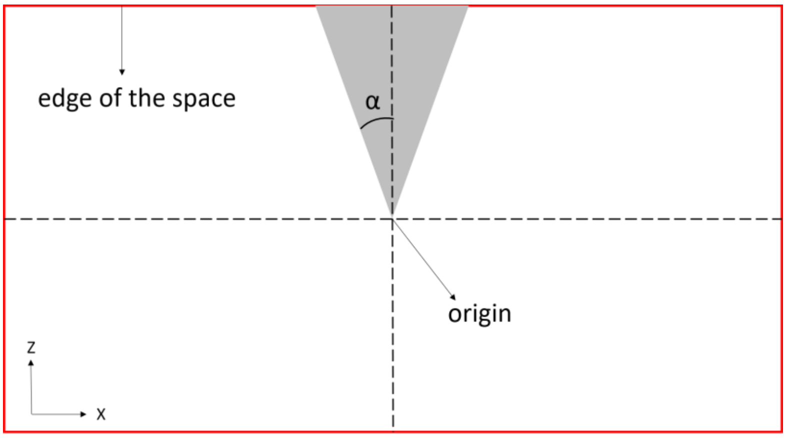
Python H.W.2

In physics, Laplace's equation is a second-order partial differential equation which can be seen as a source-free case of Poisson's equation. Due to the mean value property of Laplace's equation, we can easily determine the potential of any point in the source-free region by the average of the 6 nearest points.

$$\boldsymbol{V}(\boldsymbol{x},\boldsymbol{y},\boldsymbol{z}) = \frac{\boldsymbol{V(x+\partial x,y,z)+V(x-\partial x,y,z)+V(x,y+\partial y,z)+V(x,y-\partial y,z)+V(x,y,z+\partial z)+V(x,y,z-\partial z)}}{\boldsymbol{6}} \quad \text{---(1)}$$

Consider an infinity conducting cone with half angle $\boldsymbol{\alpha} = 15^{\mathrm{o}}$ is maintained at potential $\boldsymbol{V_0} = 10\ \mathrm{V}$ and the tip of the cone lays on the origin point as shown in the figure below. Assume the potential at the edge of the space is zero. Plot the potential distribution with the density plot and the electric field using the stream plot on X-Y and X-Z plane.



Hint:

1. Density plot: https://tree.rocks/python-matplotlib-plt-contour-or-contourf-tutorial-with-sklearn-e4497f76280
2. Using a $n \times n \times n$ matrix to describe the potential in space, where n is the space size. Some NumPy tools may be helpful like zeros. https://numpy.org/doc/stable/reference/generated/numpy.zeros.html
3. Set the potential of unknown points to zero, or whatever reasonable value you like, at the beginning for the initial condition. Then you can replace them using eq. (1). After many iterations, the potential matrix will converge to the results.
4. It is important to make sure that the boundary condition (i.e., the potential of the conducting cone) is fixed. Think of a way to do it!
5. Note that you could also use other methods to calculate your answers. You don't have to follow the suggested procedures above.