**Assignment 3: 3D Vector Visualization: Visually Explore the Velocity Distribution in a Particular Region**

**Objective:**

In this assignment, you will explore vector data like velocity of air flow inside a cavity of size 18x18x10. In Assignment 2, you have already explored temperature distribution of airflow inside the same cavity. Now, you will explore the velocity distribution of the air flow. At first, you will explore the global velocity distribution. Next, you will analyze the velocity distribution along the boundary, inside the cavity, and along the z-axis. You will also explore the plane of symmetry and establish a relationship between the temperature (as you did in Assignment 2) and air flow (velocity) inside the cavity.

## To do lists:

1. **Global velocity distribution:**
   Explore global velocity inside the cavity. Use '**vtkStructuredPointsReader**' as you already used in Assignment 2 to read the velocity data. Use the attached **velocity.dat** file. Use '**vtkArrowSource**' or '**vtkConeSource**'as '**glyph**' to explore the direction of velocity as discussed in the lecture. Lastly, use vtkPolyDataMapper with glyphs as input. You will have to color the velocity data with its scalar magnitude:

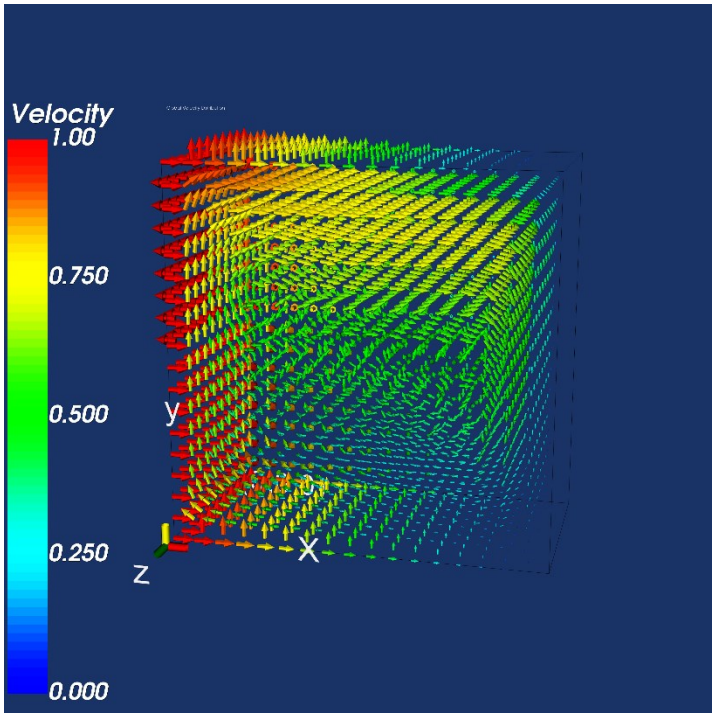



Figure 1: Global Velocity Distribution inside the Cavity.

2. **Velocity Exloration inside the Cavity:**
   Now, explore the air flow distribution inside the cavity. You need to use vtkRungaKutta4 method for velocity distribution inside the grid. Next, you need to use vtk StreamTracer

that takes as input some seed point and finds velocity at discrete intervals via integration. Next, the traced path of the velocity is wrapped in a tube for better visualization.

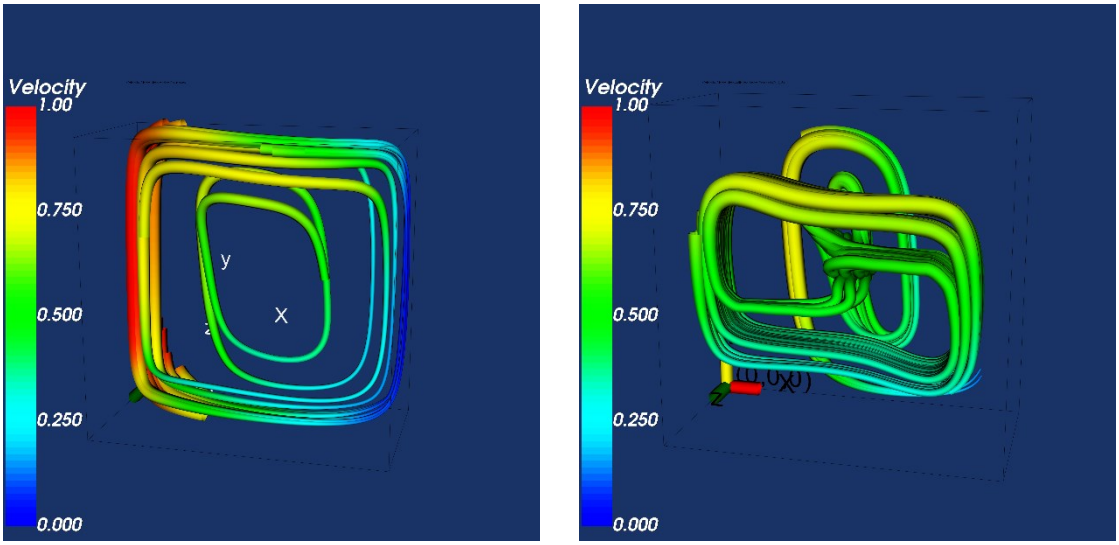
Some part of the code is shown below:

```
vtkPointSource seeds
      seeds SetRadius 3.0
      seeds SetCenter 0 0 0
      seeds SetNumberOfPoints 100
vtkRungeKutta4 integ
vtkStreamTracer streamer
      streamer SetInputConnection [reader GetOutputPort]
      streamer SetSourceConnection [seeds GetOutputPort]
      streamer SetMaximumPropagation 100
      streamer SetInitialIntegrationStep 0.1
      streamer SetIntegrationDirectionToBoth
      streamer SetIntegrator integ

vtkTubeFilter streamTube
    streamTube SetInputConnection [streamer GetOutputPort]
    streamTube SetRadius 0.05
```

Again, you need to use vtkPolyDataMapper which takes vtkTubeFilter as input. You need to use a number of seed points for proper exploration of velocity distribution. Explore velocity distribution along the boundary by taking some seed points at the boundaries of the cavity. Similarly, explore velocity distribution in the middle of the cavity. Try to explore whether there is any vortices. When vortices are formed, suddenly velocity becomes perpendicular to the original flow.

Figure 2a and 2b demonstrate the velocity distriburion along the boundary and in the middle of the cavity with seed points taken at (0, 0, 0) and (9, 9, 5) respectively.




(a) (b)

Figure 2: Velocity distribution (a) along the boundary and (b) inside the cavity.

3. **Velocity Exploration along the z-axis:**
   Explore the velocity distribution along the Z axis. Take some seed points as mentioned at different intervals along the z direction. Can you identify the plane of symmetry? Can you draw a relationship between the velocity and temperature distribution? Explain velocity distribution along the z-axis.

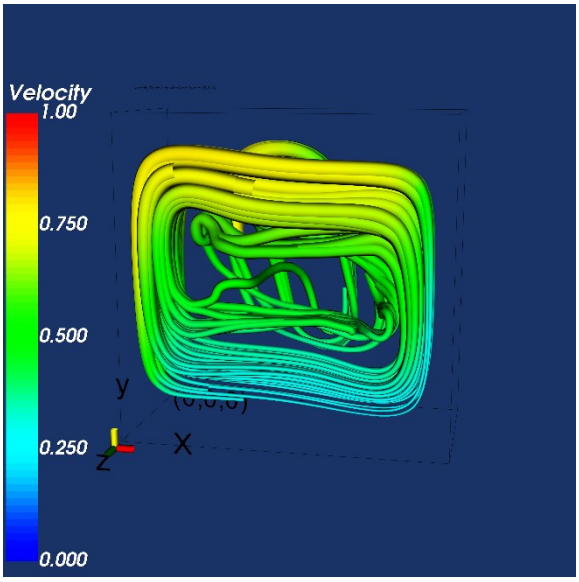



Figure 3: Air flow distribution at z =9 with seed point at (5, 5, 9).

## Implementation and Submission:

This is not a group assignment, each student needs to do the assignment. Submit all the necessary codes that you need to write to explore velocity distribution. Write down your analysis in a pdf file named **3DVectorVisualiztion.pdf**. Submit all vtk codes and pdf file in a zipped file named **LastName_FirstLetter ofFirstName_Assignment3.zip**.

Submission deadline is **Friday, November 16**.

This assignment carries 25% of the course evaluation.


## Acknowledgement:

The instructor is thankful to the University of Leeds, UK and Professor Bahari Belaton of Universiti Sains Malaysia for the data used in this assignment.