**Lab 4 – Dimensionality Reduction and MLP ANSWERS**

1. Give some intuitive reason why unit hypersphere volume decreases (rather than increases) as # of dimension exceeds 5.

**Ans.** Let’s consider a unit circle (i.e. in 2D). If we add a 3rd dimension, then one option is to get a cylinder. The volume of this cylinder is pi x r^2 x h i.e. 3.14 x 1 x 2 = 6.28 as pi = 3.14 and height is 1 unit from the center to both sides etc. But if you make a unit sphere, the volume is 4.18. Clearly, when we make a sphere (instead of cylinder), the volume is smaller, mainly because of the shape of a sphere. In other words when you rotate a circle to make a sphere, you cover less volume than when you move a circle 2 units to make a cylinder (rotation covers less space than liner shift of a circle). Thus for the hypersphere, the volume gradually shrinks. This intuitive argument supports the equation for the volume of a hypersphere in any dimension.

1. Dimensionality Reduction is very important, especially, considering using Machine Learning in Big Data applications. Below are the 2 papers you need to read. These will help better understand what we covered in the class. These would also help you in your project as well as when you will join the industry. The first paper is relative easier than the 2nd one which has more math.

a. <https://ieeexplore.ieee.org/document/9036908>

**Analysis of Dimensionality Reduction Techniques on Big Data**

1. <http://jmlr.org/papers/volume16/cunningham15a/cunningham15a.pdf>

**Linear Dimensionality Reduction:  
Survey, Insights, and Generalizations**

Just write a short summary of the **first paper and any key points that can be used in your project. In case you are not addressing any DR for your project now, write how DR can affect your project in future when you may have large data with many dimensions.**

1. **Write any key points that you have learned from the paper that you can possibly use in your project.**  In case you are not addressing any DR for your project now, write how DR can affect your project in future when you may have large data with many dimensions.