**Write a paragraph or two defining each of these topics:**

**Vectors**

Vectors – often depicted with a small arrow overtop the symbol or in boldface font – are lists of numbers that can be interpreted as a way to identify a point in space like a coordinate. In this case each number represents the vector’s component for that dimension. Another way to interpret a vector is a magnitude and a direction, where the vector can be visualized as a directed arrow pointing form the origin to the end point given by a list of numbers.

**Matrix**

Matrices are similar to vectors in that they also can contain a collection of numbers, however matrices are arranged as rectangular arrays or tables, rather than lists. We can even consider vectors as matrices that only have one column or one row. Matrices often represent linear maps that allow for explicit computations in linear algebra and are subject to standard operations.

**Linear equations**

Linear equations are equations containing variables, coefficients, and constants that together form straight lines, in which the highest power of the variable is always 1. It is known as a one-degree equation with a standard form containing one variable depicted as Ax+B=0 – for variable x. Similarly the standard form of two variables, x and y,can be depicted as Ax+By + C = 0.

**Vector space in multiple dimensions**

All vectors live within a vector space. A vector space is a space in which vectors live, and can be depicted as a spatial map that the vectors are contained in. The vector space can contain multiple dimensions, and therefore can be defined by a linear combination of the basis vectors that span the space. By multiplying the basis vectors by scalar constants, we can describe any state in the entire vector space. By removing any of the basis vectors, we will no longer be able to describe the entirety of the vector space, and therefore the basis set is a linearly independent set of vectors that, when used in linear combination, can represent every vector in a given vector space.

**Linear Transformations**

Linear transformations are a special subset of functions that take vectors as inputs and can be written as a matrix multiplication: **y** = A**x**. A few useful linear transformations include the identity (I), stretch and squash (S), Skew (W), and Flip (F). Since a linear operator is anything that can be expressed as a matrix, that means that by sticking any series of linear operators together we can create a new function, and that function will also be a linear operator. As a result, any set of linear transformations, no matter how long, can be condensed into a single operator.

**Linear independence**

Two vectors are said to be linearly independent if no one of the vectors can be created by any linear combination of the other vectors in the family. That is, if two vectors point in different directions, even if they are not very different directions, then the two vectors are linearly independent, since no linear combination of the first vector will result in the second. Similarly, **c** is linearly independent of **a** and **b**, if and only if it is impossible to find scalars such that **c =** m**a** + n**b**.

**Eigenvalues and Eigenvectors**

Eigenvectors or characteristic vectors of a linear transformation are nonzero vectors that change at most by a scalar factor when the linear transformation is applied to it. The corresponding scalar factor is called the eigenvalue. For a matrix, eigenvalues and eigenvectors can be used to decompose the matrix.

**Orthonormal bases and compliments**

If the orthogonal basis – made up by vectors that make up that vector space – are pairwise orthogonal – then they form an orthonormal basis. The orthogonal compliment of the subspace of the vector space is the set of all vectors in the vector space that are orthogonal to every vector in the subspace and can make up inner product spaces. The vectors that make up the orthonormal basis are mutually perpendicular and have a length of 1. Usually, orthonormal basis are convenient when using a basis to do calculations as they simplify the computations, for example the formula for a vector space projection. They are also useful as a set of eigenvectors for a symmetric matrix.

**Compare and contrast data mining, machine learning and deep learning**

Data mining and machine learning enable one to gain fundamental insights and knowledge from data. Data mining, also popularly referred to as knowledge discovery from data, is the automated or convenient extraction of patterns representing knowledge implicitly stored or captured in large databases, data warehouses, the Web, data streams, or other massive information repositories. Data mining draws on work from areas of statistics, machine learning, pattern recognition, database technology, information retrieval, network science, knowledge-based systems, artificial intelligence, high-performance computing, and data visualization, and focusses on issues relating to the feasibility, usefulness, effectiveness, and scalability of techniques for the discovery of patterns hidden in large data sets. While data mining is used to characterize data, machine learning – the process of machines learning from heterogeneous data in a way that mimics the human learning process – allows for predictions to be made about future data based on the available data. Deep learning is a type of machine learning that imitates the way humans gain certain types of knowledge. Therefore, both machine learning and deep learning can be used in data mining to process the available data.