Vector Cont.

ILC Continued Notes

Vector-Scalar Multiplication

- A scalar is a standalone number, not embedded in a vector or matrix.
- Vector-scalar multiplication is the process of multiplying each element of the vector by the scalar.

The Zeros Vector

- A vector of all zeros is called the zeros vector and is a special vector in linear algebra.
- The zeros vector is often used to solve problems and represents the trivial solution.

Data Types in Vector-Scalar Multiplication

- The data type of a variable storing a vector matters when it comes to vector-scalar multiplication.
- Python interprets multiplication differently for a list and a NumPy array; for lists, multiplication duplicates the list, while for NumPy arrays, it multiplies each element by the scalar.

Scalar-Vector Addition

- Adding a scalar to a vector is not formally defined in linear algebra, but it's possible in Python.
- This operation adds the scalar to each element of the vector.

Geometry of Vector-Scalar Multiplication

- Scalars are called such because they scale vectors without changing their direction.
- The effects of vector-scalar multiplication depend on the value of the scalar.

Vector Averaging

- Averaging vectors is similar to averaging numbers: sum and divide by the number of numbers.
- To average N vectors, sum them and scalar multiply the result by 1/N.

Transpose

- The transpose operation converts column vectors into row vectors and vice versa.
- In matrix terms, the transpose operation swaps the row and column indices.
- Transposing twice returns the vector to its original orientation.

Vector Broadcasting in Python

- Broadcasting is an operation unique to computer-based linear algebra, repeating an operation multiple times between one vector and each element of another vector.
- The orientation of vectors is essential in broadcasting.
- Because of its efficiency and compactness, broadcasting is often used in numerical coding.

Vector Magnitude (Geometric Length, Norm): The distance from tail to head of a vector. Computed using the standard Euclidean distance formula: the square root of the sum of squared vector elements. Notation: ⫽ v ⫽.

- **Squared Magnitudes**: In some applications, squared magnitudes (written ⫽ v ⫽^2) are used, in which case the square root term drops out.

In **Python**, the function `len()` returns the dimensionality of an array, while the function `np.linalg.norm()` returns the geometric length (magnitude).

Unit Vector: A vector that has a geometric length of one. Notation: ⫽ v ⫽ = 1. Unit vectors are common in applications including orthogonal matrices, rotation matrices, eigenvectors, and singular vectors.

Creating a Unit Vector: An associated unit vector can be created from any nonunit vector by scalar multiplying by the reciprocal of the vector norm. Notation: v = 1/⫽ v ⫽v.

Vector Dot Product

important:

Dot Product (Inner Product): One of the most important operations in linear algebra. Provides information about the relationship between two vectors.

Dot Product Notation: There are several ways to indicate the dot product between two vectors: aTb, a · b, or a, b.

Computing the Dot Product: Multiply the corresponding elements of the two vectors and then sum over all the individual products. Notation: δ = ∑(ai*bi) for i from 1 to n.

- **Python Implementation**: `np.dot()` function is used in Python to compute dot product. However, it actually implements matrix multiplication, which is a collection of dot products.
- **Dot Product Interpretation**: Can be interpreted as a measure of similarity or mapping between two vectors. Normalized dot product between two variables is

called the Pearson correlation coefficient.

- **Distributive Property**: The dot product of a vector sum equals the sum of the vector dot products. Notation: aT(b + c) = aTb + aTc. This property can be demonstrated with Python code.