

Linear Algebra & Probability HW 4

Assignment

Matrices, recap

1. For any row i , of a matrix M , and column j of its inverse M^{-1} show why they must be orthogonal if $i \neq j$.
2. If the matrices A and B 's product is $AB = 0$, show that the column space of B is contained in the nullspace of A .

Inner products

1. Show that when two vectors align their inner product is the product of their lengths.
2. For a vector of all ones of length n , e.g. $(1_1, 1_2, \dots, 1_n)$ compute its angle with the x axis.

Projections

1. Is a projection matrix invertible? Why or why not?
2. For $P = A(A^T A)^{-1} A^T$. Using this definition prove the two properties of projection operators: $P = P^2$ and $P = P^T$.
3. Show how the Projection operator simplifies when the columns of A are orthogonal and of unit length.

Probability

1. Show why two events that are mutually exclusive cannot be probabilistically independent.
2. Notebook exercise in visualization. Find a publicly available dataset. See for example:

```
# There are 22 datasets available from the Seaborn statistical plotting library
import seaborn as sns

# For instance, the titanic dataset lists passengers by row. The first column is
# followed by columns with the features describing each customer.
titanic = sns.load_dataset('titanic')
```

Choose two variables, and find an appealing way to visualize their marginal distributions, and their conditional distribution— to make clear if they are or are not independent.