St. Xavier's College (Autonomous), Kolkata

Department of Statistics

MSc in Data Science

Paper code: MDSC 4113

Module 1

Linear Algebra

Handout for Problem sheet 3

3.1 Explore the following functions under Matlib

install.packages('matlib')

library(matlib)

- tr() - trace of a matrix
- R() - rank of a matrix
- Det(A)
- Inverse(X), inv() - uses gaussianElimination to find the inverse of X
- len() - Euclidean length of a vector or columns of a matrix
- vec() - vectorize a matrix
- Proj(y, X) - projection of vector y on columns of X
- mpower(A, p) - matrix powers for a square symmetric matrix

- The minor of an element is equal to the determinant of the matrix remaining after excluding the row and column containing the element:

  minor(A,i,j)-Minor of A[i,j]

  rowMinors(A,i): gives all the minors corresponding to ith row of A

- The cofactor of an element is equal to the product of the minor of the element, and -1 to the power of the row +column of the element:

  cofactor(A,i,j) - Cofactor of A[i,j]

  rowCofactors(A,i): gives all the cofactors corresponding to the ith row of A

  Let A be a $K \times K$ dimension matrix, the cofactor expansion along the i-th row is defined with the following formula: Det(A) = $\sum_{j=1}^{k} A_{ij} C_{ij}$

3.2 Gram-Scmidt Orthogonalization (matlib)

Carries out simple Gram-Schmidt orthogonalization of a matrix. Treating the columns of the matrix X in the given order, each successive column after the first is made orthogonal to all previous columns by subtracting their projections on the current column.

```
GramSchmidt(
  X,
  normalize = TRUE,
  verbose = FALSE,
  tol = sqrt(.Machine$double.eps)
)


# tol: the tolerance for detecting linear dependencies in the columns of a. The default
is .Machine$double.eps
```

3.3 Row Reduced Echelon Form

A matrix that has undergone Gaussian elimination is said to be in row echelon form or, more properly, "reduced echelon form" or "row-reduced echelon form."

a). install.packages('pracma')

```
library(pracma)

# enter matrix A

A <- matrix(1:9, 3, 3)

help(rref)

rref(A)
```

b). install.packages('matlib')

```
library(matlib)

# enter matrix A

A <- matrix(1:9, 3, 3)

echelon(A, reduced=T, verbose=TRUE, fractions=T)    # row reduced, verbose: shows all the steps,
fractions: gives the outputs in fractions
```