

ECE 445 (ML for ENGG): Homework #2

Waheed U. Bajwa (waheed.bajwa@rutgers.edu)

1. Consider a matrix $\mathbf{A} \in \mathbb{R}^{M \times M}$. What is the relationship between the invertibility of \mathbf{A} and the rank of \mathbf{A} ?
2. Consider a system of linear equations involving N equations and M unknowns. What can be said for the solution of this system of linear equations when:
 - $N < M$ (undetermined system; more unknowns than equations)
 - $N = M$ (same number of unknowns as the number of equations)
 - $N > M$ (overdetermined system; more equations than unknowns)
3. Specify whether the following problems are classification, regression, or clustering problems:
 - A financial analyst is interested in knowing the stock price of Apple in the next 30 seconds based on last week's GDP and unemployment figures and stock prices of other technology stocks in the last 30 minutes.
 - A bank is interested in dividing its mortgage customers into groups of individuals with similar traits, which are not known ahead of time.
 - A mobile operator is interested in knowing whether a given customer is going to switch to another carrier in the next three months.
4. Consider two random variables X and Y , where it is assumed that $Y = f(X) + \epsilon$, where ϵ represents modeling error. It is assumed that $f \in \mathcal{F} = \{\text{All functions that are bounded and at least twice differentiable}\}$. Specify whether this is (i) a linear or a nonlinear model, and (ii) a parametric or a nonparametric model.
5. Consider a random vector $\mathbf{X} \in \mathbb{R}^M$ and a random variable Y , where it is assumed that $Y = \mathbf{a}^T \mathbf{B} \mathbf{X} + c$, where $\mathbf{a} \in \mathbb{R}^p$ and $\mathbf{B} \in \mathbb{R}^{p \times M}$. Specify whether this is (i) a linear or a nonlinear model, and (ii) a parametric or a nonparametric model.