

PS0: Preparation Self-Assessment (Due Sep 3)

Course Setup and Background Assessment

CEVE 543 Fall 2025

2025-08-25

This is an **ungraded** self-assessment designed to help you gauge your readiness for the course. The goal is not to test you, but to give you a clear picture of the prerequisite knowledge we'll be building on.

You should be able to understand and tackle the questions in this assignment. If you find you're rusty on something and need to check your notes or online resources, that's OK. If you find the majority of these questions unfamiliar or challenging, please reach out to me so we can discuss the best path forward for you.

Solutions will be posted to Canvas.

1 Matrix Multiplication

Let \mathbf{A} be a 2×3 matrix and \mathbf{B} be a 3×4 matrix.

1. What is the dimension of the product $\mathbf{C} = \mathbf{AB}$?
2. If C_{ij} is the element in the i -th row and j -th column of \mathbf{C} , write a formula for C_{ij} in terms of the elements of \mathbf{A} and \mathbf{B} .

2 System of Equations

Consider the following system of linear equations:

$$\begin{aligned} 3x + 2y &= 7 \\ x - 4y &= -1 \end{aligned}$$

1. Represent this system in the form $\mathbf{M}x = b$, identifying the matrix \mathbf{M} and the vectors x and b .
2. Solve for the vector x .

3 PDF and CDF

Let X be a continuous random variable representing daily rainfall in inches. Its probability density function (PDF) is given by $f(x) = 2(1 - x)$ for $0 \leq x \leq 1$, and $f(x) = 0$ otherwise. What is the probability of observing more than 0.5 inches of rain on a given day?

4 Regression

City planners in Houston are developing a model to predict daily water demand during the summer. They use linear regression to model Demand (in millions of gallons per day) based on the AvgTemp (average daily temperature in $^{\circ}\text{C}$) and Rainfall (total daily rainfall in mm). The fitted model is:

$$\text{Demand} = 120 + 10 \cdot \text{AvgTemp} - 8 \cdot \text{Rainfall}$$

1. Interpret the meaning of the coefficient for AvgTemp (10) in the context of this model.
2. Interpret the meaning of the coefficient for Rainfall (-8). Explain why the negative sign makes physical sense.
3. Planners in New Orleans want to fit a similar model. They have collected data on demand, average temperature, and rainfall. Explain how you would estimate the coefficients.

5 Sea-Level Rise

 Credit

Based on part of an assignment by Vivek Srikrishnan at Cornell

Consider the following sea-level rise model:

$$\frac{dS}{dt} = \frac{S_{\text{eq}} - S}{\tau}$$

$$S_{\text{eq}} = aT + b$$

where $S(t)$ is the global mean sea level (in mm) at time t , τ is the response time of the sea level (in years), S_{eq} is the equilibrium sea-level (in mm) at temperature T (in °C), a is the sensitivity of sea-level rise to temperature (in mm/°C), and b is the equilibrium sea level (in mm) when $T = 0^\circ\text{C}$.

Describe, using code or a paragraph, how you would write a function to simulate the global mean sea level $S(t)$ over a given period. Assume your function will receive the following inputs: an initial sea level, S_0 , a time series of annual temperatures, $T(t)$, and model parameters a , b , and τ . You will need to select a time step, Δt , for your simulation. You may use $\Delta t = 1$ year.

6 Programming

Solve Project Euler Problem 1: “If we list all the natural numbers below 10 that are multiples of 3 or 5, we get 3, 5, 6 and 9. The sum of these multiples is 23. Find the sum of all the multiples of 3 or 5 below 1000.”

Bibliography