

Problem Set 1: Mathematical Programming

50 points

Version 1.0

due Friday, 27 January 2023, by 11:00 PM CT

Review the following assignment in its entirety prior to beginning. All submissions will be managed from within the course website.

Application Development

We will use the bar notation ($\bar{\cdot}$) over some vector (e.g. $\bar{\mathbf{x}}$, $\bar{\mathbf{y}}$, $\bar{\mathbf{x}}_1$) to represent the average function over the vector as input. Let \mathbf{X} be a matrix comprised of n rows and p columns. Here are a couple of ways to visualize \mathbf{X} :

$$\mathbf{X} = [\mathbf{x}_1 \quad \mathbf{x}_2 \quad \cdots \quad \mathbf{x}_p] \quad \mathbf{X} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1p} \\ x_{21} & x_{22} & \cdots & x_{2p} \\ \vdots & & \ddots & \\ x_{n1} & x_{n2} & \cdots & x_{np} \end{bmatrix}$$

For example, \mathbf{x}_1 could be a column vector that represents all n values in the first column. \mathbf{X} would be the entire matrix comprised of p column vectors. While we could also represent rows in this manner, we will avoid doing so to avoid any confusion about what each vector represents.

$$\bar{\mathbf{x}} = \text{average}(\mathbf{x}) = \frac{\sum_{i=0}^n x_i}{n}$$

$$\alpha(\mathbf{x}_j) = \text{run1}(\mathbf{x}_j) = \sum_{i=0}^n \left[x_j^{(i)} - \bar{\mathbf{x}}_j \right]^2$$

$$\text{run2}(\mathbf{X}) = \sum_{j=1}^p \sqrt{\alpha(\mathbf{x}_j)}$$

To help you understand the notations, consider the following:

1. \mathbf{x} refers to a column vector
2. $x_j^{(i)}$ refers to some value located in column vector j at row i
3. \mathbf{X} refers to an $n \times p$ matrix comprised of n rows and p columns
4. $\bar{\mathbf{x}}_j = \text{average}(\mathbf{x}_j)$
5. $\alpha(\mathbf{x}_j) = \text{run1}(\mathbf{x}_j)$ (note that $\alpha(\cdot)$ is a function call)

A starter file has been provided for you on the course website. See `ProblemSet1.java`. The application is already set to accept command line arguments. The input file will be a comma-delimited file comprised of multiple lines.

Report

Submit a report written in Latex with the following components:

1. Write a paragraph or two that describes the data structures you used and how you implemented the algorithms. The goal is to articulate how the code works. For example: *The algorithm iterates over all [something] by calculating [some calculation].*
2. Submit a single equation for the $\text{run2}(\mathbf{X})$ function by removing all calls to $\text{run1}(\mathbf{x})$ and $\text{average}(\mathbf{x})$. In other words, simply have a single equation that describes mathematically the computations using a single, inline equation. It should be defined as follows:

$$\text{run2}(\mathbf{X}) = \text{write equation here}$$

Deliverables

You will be responsible for delivering the following items:

1. Latex Documents – your latex code should be used to generate a PDF which will then be submitted. Be sure that all documents submitted list your name, problem set information, date and class.
2. Application Code – All submitted code must have your 1) name 2) problem set number and 3) due date as a comment at the top of each class.

```
/*****  
Name:           Andrew Mackey  
Username:       ua12345 <if applicable>  
Problem Set:    PS#  
Due Date:       Month day, YEAR  
*****/
```