MATLAB Basics

- Compute 4 to the power of 5 in MATLAB.
- Set the variable $a$ as the value 3.27.
- Using the numbers 1, 2, and 3, make a row vector using these numbers only once.
- Using the numbers 1, 2, and 3, make a column vector using these numbers only once.
- Explain what the command 1:10 does.
- Suppose you have a vector $x$. What would you type into MATLAB to access the eighth element?
- Suppose you have a matrix $A$. What would you type into MATLAB to access the 3rd row, 4th column?
- Suppose $x$ is a $1 \times n$ vector and $y$ is a $n \times 1$ vector. Explain the difference between $x*y$ and $x.*y$ in MATLAB.
- You need documentation on the function `lsqnonlin()`. What would you type into MATLAB to pull up information on this function?

Linear Transformations

Given a data point $(a, b)$:

- Write the linear transformation as a matrix $A$ in MATLAB which projects the point to the x axis. What is the value of this new point?
- Write the linear transformation as a matrix $A$ in MATLAB which reflects across the x axis. What is the value of this new point?
- What’s the linear transformation such that the new point would be $(2a, b)$?
Special Matrices

• Generate a matrix of zeros of size $40 \times 50$ in MATLAB. Store this as the variable $Z$.
• Generate a matrix of ones of size $36 \times 36$ in MATLAB. Store this as the variable $0$.
• Generate an identity matrix of size $250$ in MATLAB. Store it as the variable $Iden$.
• Suppose you have a matrix $A$ in MATLAB. Using MATLAB functions, make a new matrix, called $Adiag$, that has the diagonal entries of $A$ on its diagonal and zero everywhere else.
• Suppose you have a matrix $A$. What does $\text{triu}(A)$ do?
• Given matrix $A$, make a symmetric matrix, called $Asym$, using MATLAB functions.
• Write the MATLAB command to compute the (a) transpose and (b) conjugate transpose of a complex matrix $A$.

Special Functions

• What’s the difference between * and .*?
• What’s the difference between ^ and .^?
• Given matrix $A$, what does $A^{-1}$ compute?
• Give another way to compute $A^{-3}$ using the function $\text{inv()}$.
• Given matrix $A$, state the difference between $\text{exp}(A)$ and $\text{expm}(A)$
• What does $\text{sqrtm}(A)$ compute?

Determinants

• Given vectors $u$ and $v$, compute the dot product using a MATLAB function.
• Compute the 2 norm and the 1 norm of a vector $v$ using a MATLAB function.
• Given matrix $A$, compute the size.
• What does the MATLAB function $\text{rank()}$ do?
• Given matrix $A$, compute the determinant.
• Given matrix $A$, compute the trace.
• Using the functions $\text{diag()}$ and $\text{sum()}$, compute the trace of a matrix $A$. 
Cramer’s Rule
Assume you have the system \( Ax = b \), where \( A \) is \( n \times n \) and nonsingular.

- Replace the first column of \( A \) with the vector \( b \) in MATLAB.
- Using determinants, compute the first element of \( x \).
- Repeat the above two with the more general \( i^{th} \) column.
- Using the fact that \( AA^{-1} = I \), write MATLAB code for what \( b \) would be.
- Compute the first element of \( A^{-1} \) in MATLAB code using Cramer’s rule.

Elementary Matrices
Assume you have the system \( Ax = b \), where \( A \) is \( n \times n \) and nonsingular.

- Write code that generates the elementary matrix of the row operation: \( 2R_4 \rightarrow R_4 \).
- Write code that generates the elementary matrix that swaps row 2 and 3.
- Write code that generates the elementary matrix of the row operation: \( R_2 - 2R_1 \rightarrow R_2 \).
- Using a MATLAB function, compute the row reduced echelon form of the given system.

Powers of Matrices
- Consider the recurrence relation: \( x_n = Ax_{n-1} \). What eigenvalue does the steady-state vector \( x \) correspond to?
- Use a MATLAB function to store the eigenvalues as a diagonal matrix \( E \) and the eigenvectors as a matrix \( V \).
- Consider the difference equation:
  \[
  x_n = 2x_{n-1}, \quad x_1 = 1;
  \]
  Compute the first 10 values of this difference equation, using a for loop, and store them in a vector called \( x \). Suppose you have the recurrence relation \( x_n = Ax_{n-1} \), with \( x_1 = v \). Write MATLAB code that will compute \( x_n \) using only \( A \) and \( v \).
Computation Times

- Suppose I have a matrix $X$ and I wish to estimate the time it takes to compute $\text{svd}(X)$. Write MATLAB code that accomplishes this.

- What is the difference between:
  $$\texttt{tic; X}^{50}; \texttt{toc};$$
  
  and
  $$\texttt{tic; X}^{50}; \texttt{toc};$$

Miscellaneous from Projects

- Given matrix $A$, compute the singular values using MATLAB functions and store it as the vector $\text{sv}$.

- Write the matrix used in Arnold’s cat map.

- Suppose you have a probability (or transition) matrix $A$ of size $n \times n$, such that the columns sum to 1. What do you expect $\text{sum}(A)$ to give you? Be specific.

Miscellaneous Plotting

- Suppose you have x axis data stored as the vector $x$ and y axis data stored as the vector $y$. Plot the data against each other using MATLAB.

- Using the same vectors, plot the data as black colored points.

- What’s the difference between Markersize and LineWidth?

- Suppose I have new vectors, $x2$ and $y2$, which I want to plot on top of the previous plot. Write the MATLAB code that does this.

- Suppose an image is stored as a matrix $C$. Write the MATLAB command that will reproduce the image in a figure.

Exporting/Importing Data

- Using a MATLAB function, import data stored in the file data.txt.

- Using a MATLAB function, export data contained in the variable $A$ to a file named data.txt.