Lab: An introduction to vectors and matrices in Octave

In this lab you will learn how to perform matrix computations in Octave, a free numerical software that uses a language compatible with MATLAB. To perform the operations below, point your web browser to `octave-online.net`. For this entire lab, you will only need to enter lines of code into the Octave Command Prompt. No sign-in is necessary.

Entering vectors and matrices in Octave

1. To define a vector in Octave you can use the syntax `A=[1,2,3,4]` or `B=2:5`. Try typing both commands separately into the Command Prompt. Octave will save your vectors under the variable names `A` and `B` so that you can refer to them later.

   Now compute the following by entering the expressions below in the Command Prompt:

   (a) `A+B`

   (b) `A-B`

   (c) `3*A`

   (d) Enter `A'`. What is the difference between `A` and `A'`?

2. **Some special matrices.** There are special commands in Octave to create some useful matrices. Try the following commands:

   (a) `eye(2)`

   (b) `eye(3)`

   (c) `ones(5)`

   (d) `zeros(5)`

3. **General matrices.** To define a matrix in Octave, type the entries in row-by-row, and separate rows by semicolons. For example, to define the matrix
$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix},$$
type `A = [1,2,3;4,5,6;7,8,9]` in the Command Prompt. Practice by entering the matrix
$$B = \begin{bmatrix} 1 & 3 & -1 & 1 \\ 0 & 2 & 3 & 1 \end{bmatrix}$$
on your own.

   Once you are able to enter matrices, Octave can perform mathematical operations as long as they are defined. Try entering `A+B` in the Command Prompt (where `A`, `B` are the matrices you practiced on above). What error message do you get?

Matrix multiplication

4. Compute the following matrix products in Octave. To complete this task, enter the left matrix as `A`, the right matrix as `B`, and compute `A*B`:

(a) $\begin{bmatrix} 2 & 4 \\ 1 & 3 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

(b) $\begin{bmatrix} 0.5 & 0.3 \\ 0.1 & 0.7 \end{bmatrix} \cdot \begin{bmatrix} 2 & 0 & 4 \\ 1 & 1 & 6 \end{bmatrix}$

(c) $\begin{bmatrix} 4 & 3 & 3 \\ 2 & 5 & 4 \\ 1 & 1 & 8 \end{bmatrix} \cdot \begin{bmatrix} 1 & 2 & 1 \\ 8 & 4 & 6 \\ 7 & 3 & 8 \end{bmatrix}$

(d) $\begin{bmatrix} 1 & 2 & 1 \\ 8 & 4 & 6 \\ 7 & 3 & 8 \end{bmatrix} \cdot \begin{bmatrix} 4 & 3 & 3 \\ 2 & 5 & 4 \\ 1 & 1 & 8 \end{bmatrix}$

(e) $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 4 & 3 & 3 \\ 2 & 5 & 4 \\ 1 & 1 & 8 \end{bmatrix}$

(f) $\begin{bmatrix} 4 & 3 & 3 \\ 2 & 5 & 4 \\ 1 & 1 & 8 \end{bmatrix} \cdot \begin{bmatrix} 2 & 0 & 4 \\ 1 & 1 & 6 \end{bmatrix}$

5. What conclusion can you draw from parts (c) and (d) in problem 4?

6. Assuming we can do the multiplication, what do you think will happen when we multiply any square matrix by the square matrix I which has 1's on the diagonal and 0's everywhere else (see parts (a) and (e) in Problem 4)?

7. What happened in part (f) of Problem 4?

8. Try the command `A.*B` using several examples from Problem 4. Can you tell determine what operation Octave is completing?

9. Enter the matrix `A = [2,4;1,3]`, then try the following commands to learn more matrix operations in Octave:

   (a) `A^2` ______________

   (b) `A.^2` ______________

   (c) `size(A)` ______________

   (d) `A(1,2)` ___________________

   (e) `A(:, 2)` ___________________

   (f) `sum(A, 1)` ____________

   (g) `sum(A, 2)` ______________

   (h) `A'` ______________

Multiplicative inverses

10. Find the inverse `inv(A)` for $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ and check `A*inv(A)`.

    The answer to `A*inv(A)` *should be the* 2×2 *identity matrix.*

11. Find the inverse of $B = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 10 \end{bmatrix}$ and check `B*inv(B)`.

    You will see something funny happening here – the effects of rounding by the computer!

12. Find the inverse of the 4×4 identity matrix with the command `inv(eye(4))`.

13. Find the inverse of $C = \begin{bmatrix} 1 & 2 & 4 \\ 3 & 4 & 10 \\ 5 & 6 & 16 \end{bmatrix}$ if possible. What is returned?

    The matrix C *in this example* does not *have a multiplicative inverse.*