CS 512 s23 – Assignment 0 (0%)

Due by: January 20, 2023

Answer by computing and showing the computations.

A. Let: $a = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$, $b = \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix}$, $c = \begin{bmatrix} -1 \\ 1 \\ 3 \end{bmatrix}$, find:

1. $2a - b$
2. $\hat{a}$, a unit vector in the direction of a
3. $||a||$ and the angle of a relative to the positive x axis
4. the direction cosines of a
5. the angle between a and b
6. $a \cdot b$ and $b \cdot a$
7. $a \cdot b$ by using the angle between a and b
8. the scalar projection of b onto $\hat{a}$
9. a vector which is perpendicular to a
10. $a \times b$ and $b \times a$
11. a vector which is perpendicular to both a and b
12. the linear dependency between a, b, c
13. $a^T b$ and ab^T

B. Let: $A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & -2 & 3 \\ 0 & 5 & -1 \end{bmatrix}$, $B = \begin{bmatrix} 1 & 2 & 1 \\ 2 & 1 & -4 \\ 3 & -2 & 1 \end{bmatrix}$, $C = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ -1 & 1 & 3 \end{bmatrix}$, $d = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$, find:

1. $2A - B$
2. AB and BA
3. $(AB)^T$ and $B^T A^T$
4. $|A|$ and $|C|$ (note question A-12)
5. the matrix (A, B, or C) in which the row vectors form an orthogonal set
6. A^{-1} and B^{-1} (note question B-5)
7. C^{-1} (note question B-4)
8. the product Ad
9. the scalar projection of the rows of A onto the vector d with normalizing d
10. the vector projection of the rows of A onto the vector d with normalizing d
11. the linear combination of the columns of A using the elements of d
12. the solution x for the equation $Bx = d$
13. the solution x for the equation $Cx = d$ and the reason for it (note question B-7)

C. Let: $D = \begin{bmatrix} 1 & 2 \\ 3 & 2 \end{bmatrix}$, $E = \begin{bmatrix} 2 & -2 \\ -2 & 5 \end{bmatrix}$, $F = \begin{bmatrix} 1 & 2 \\ 2 & 4 \end{bmatrix}$, find:

1. the eigenvalues and corresponding eigenvectors of D
2. the dot product between the eigenvectors of D

3. the dot product between the eigenvectors of E
4. the property of the eigenvectors of E and its reason (note question C-4)
5. the value of a trivial solution x to the equation $Fx = 0$
6. the value of two non-trivial solutions x to the equation $Fx = 0$
7. the only solution x to the equation $Dx = 0$ and the reason for having a single solution

D. Let: $f(x) = x^2 + 3, \quad g(x) = x^2, \quad q(x, y) = x^2 + y^2$, find:

1. the first and second derivatives of $f(x)$ with respect to x: $f'(x)$, and $f''(x)$
2. the partial derivatives: $\frac{\partial q}{\partial x}$, and $\frac{\partial q}{\partial y}$
3. the gradient vector $\nabla q(x, y)$
4. the derivative $\frac{d}{dx} f(g(x))$ with and without using the chain rule for derivatives

E. Repeat questions A, B, C using python and prepare a python notebook showing your computations.

Submission Instructions:

1. **Step 1: Prepare your solution**
   - Prepare your solution in a pdf file (either type and export to pdf, or hand write and scan/photograph).
   - Prepare a python notebook showing the python solution.
   - Your name, student ID, course number, and semester must be clearly shown in the beginning of your report and the beginning of the Python notebook.
2. **Step 2: Create a private bitbucket repository**
   - Create a free bitbucket account or use your existing account if you have one (http://bitbucket.org).
   - From the account's webpage do the following:
     - Create a PRIVATE repository **cs512-s23-LAST-FIRST** where FIRST/LAST are your first/last name. Note that we will not accept submissions from a repository that is not private or that is not named correctly.
     - Share the repository you created (i.e. give read permission) with **cs512@cs.iit.edu**.
     - Press the clone button on the repository page and copy the clone command.
   - Paste the clone command in the following form:

     `https://forms.gle/FmmaHpsQ1ZPHH15E8`

     Note that to access the form you must be logged in your IIT Google account (through http://myiit.edu). If you are getting a message that you need permission to access the form it means you are not logged in your IIT Google account. Make sure to log out any personal account then log in again with your IIT Google account (through http://myiit.edu).
3. **Step 3: Clone your repository**
   - From a git console on your computer or by using a GUI program such as sourcetree clone the repository you created using the link you copied. For example using the git console:

     `git clone https://USER_NAME@bitbucket.org/USER_NAME/REPOSITORY_NAME.git`

     where `USER_NAME` is your bitbucket user name and `REPOSITORY_NAME` is the name of your repository.
   - After cloning the repository you have a local copy that you can modify and push back to bitbucket (see next step).
4. **Step 4: Push your submission**
   - Inside the cloned copy of your repository create a folder named AS0 and copy to this folder your submission files (a pdf solution file and a python notebook).
   - From a git console on your computer or by using a GUI program such as sourcetree commit and push the files you are submitting. E.g. from a git console use:

     ```
     git add AS0
     git commit -m "assignment 0 submission"
     git push -u origin master
     ```
   - To verify that your files were pushed correctly, login to your bitbucket account using a web browser and check that the files you pushed are showing there. We cannot provide individual confirmation to submissions.
   - Note: Making any changes to your submission by adding or modifying files inside AS0 and pushing them to bitbucket will change your submission date. Please do not make any changes if you do not want your submission date to change.