The University of Western Ontario

Computer Science 2035b

Solutions for Midterm Examination - Friday, February 26th, 2016

Surname	
Given Name	
Student Number	

This exam consists of 4 questions (10 pages including this page) worth a total of 100%. It is an open book exam, course notes and any MatLab book(s) are allowed. All answers are to be written in this booklet. Scrap work may be done on the back of each page; this will not be marked. No laptops or cell phones are allowed. The exam is 50 minutes long and comprises 20% of your final mark. Please print you full name and student number in the space provided above before you start this exam.

(1) 40%	
(2) 15%	
(3) 25%	
(4) 20%	
Total	

Professor: John Barron

(40%) Consider the following MatLab matrices `A`, `B` and `C`:

```
A= [10 15  16 18;
    90 28  12 13;
    41 23  15 59];
B=[1 2 3; 0 0 0; 3 2 1];
C=[1; 2; 3];
```

1. (4%) Using the original `A` above, if `A(3:4,4:5)=eye(2,2)` what is the value of `A`?

```
A = 10    15    16    18     0
    90    28    12    13     0
    41    23    15     1     0
     0     0     0     0     1
```

2. (4%) Using the original `A` above, if `A(2:3,:)=flipud(A(2:3,:))` what is the value of `A`?

```
A = 10    15    16    18
    41    23    15    59
    90    28    12    13
```

3. (4%) What is `B*B`:

```
B*B=| 1*1+2*0+3*3 1*2+2*0+3*2 1*3+2*0+3*1 | = | 10   8   6 |
    | 0*1+0*0+0*3 0*2+0*0+0*2 0*3+0*0+0*1 |   |  0   0   0 |
    | 3*1+2*0+1*3 3*2+2*0+1*2 3*3+2*0+1*1 |   |  6   8  10 |
```

4. (4%) What is `B.*B`:

```
B.*B= | 1*1 2*2 3*3 | = | 1  4  9 |
      | 0*0 0*0 0*0 |   | 0  0  0 |
      | 3*3 2*2 1*1 |   | 9  4  1 |
```

5. (4%) What is the value of `[B; C]`?

```
Error using vertcat
Dimensions of matrices being concatenated are not consistent.
```

6. (4%) What is the value of `[C; C]`?

```
[C;C] = 1
        2
        3
        1
        2
        3
```

7. (4%) Consider a 3 element column vector `s`. How would you solve the system of equations `B*s=C`, where `B` and `C` are as above? Do not try to solve this system of equations!!!

```
S=B\C


When I run it, I get: Warning: Matrix is singular to working precisio
       s= NaN
         -Inf
          Inf
```

8. (4%) What happens when we execute `(B*C)'`?

```
(B*C)' =   14     0    10
```

9. (4%) What happens when we execute `(C*B)'`?

```
Error using  *
Inner matrix dimensions must agree.
```

10. (4%) Using the original 3×4 array `A`, what is the value of `reshape(A,4,3)`?

```
Take the elements of A column by column (i.e. A(:)'):
10 90 41 15 28 23 16 12 15 18 13 59

Now put them in the new array column by column
reshape(A,4,3) is
    10    28    15
    90    23    18
    41    16    13
    15    12    59
[Take the elements of A column by column.]
```

(2) (15%) This is the Lab question.

1. (5%) Consider the following expression: `6-5+4*3/2^1`. Write this expression with parentheses to reflect the precedence of the operators. What is the value of the expression?

   Parenthezied expression and its value:

```
((6-5)+((4*3)/(2^1))) =  7
```

2. (10%) Consider the follow graph.

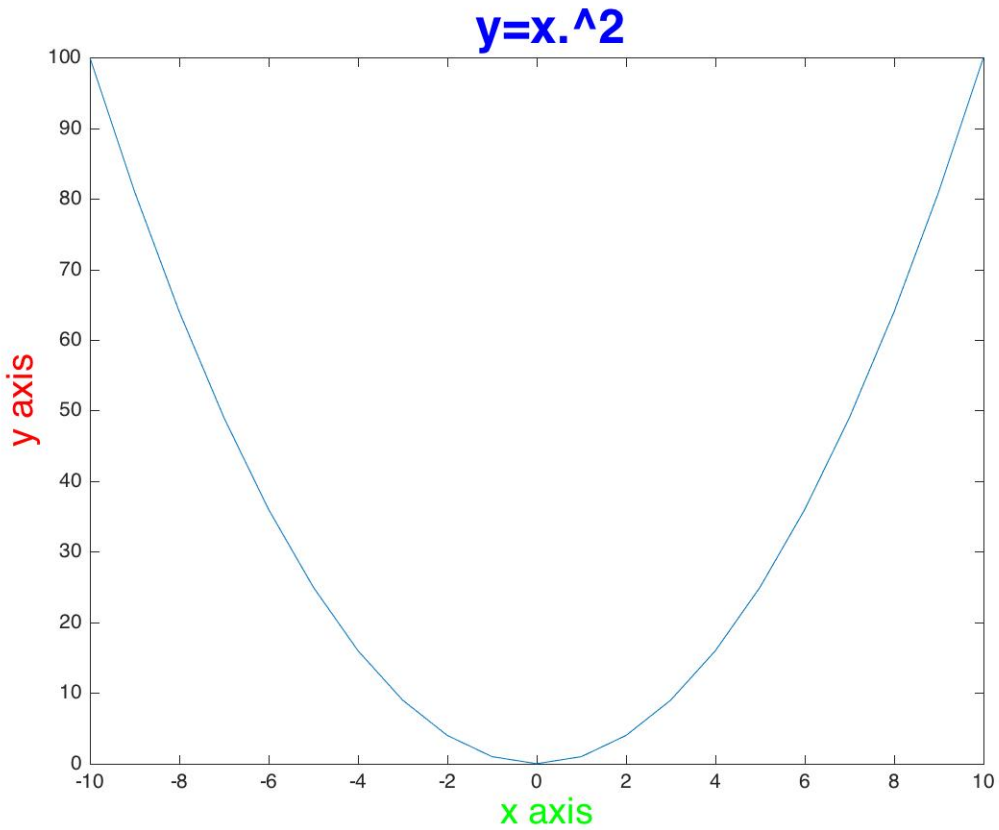

Figure 1: $y = x.\hat{}2$ for $x \in [-10, 10]$.

Give the MatLab to plot this graph. Label the x and y axes in the colours shown and usng fontsize 18. Show the title printed in the colour shown with fontsize 24. Note that in order to prevent ^ from being interpreted as a superscript you must backslash it, i.e. \^, in a chanacter string in MatLab.

Answer:

```
x=[-10:10];
y=x.^2;
plot(x,y);
title('\fontsize{24} \color{blue} y=x.\^2');
xlabel('\fontsize{18} \color{green} x axis');
ylabel('\fontsize{18} \color{red} x axis');
print midterm2016.jpg -djpeg
```

(3) (25%) This question is related to Assignment 2 in that it is about the use **circshift** and convolution. Suppose we want to compute 1^{st} order derivatives, Y_X, using a 4-point central difference `mask` with values `[1 -8 0 8 -1]/12`. Consider applying this row vector mask to a grayvalue image Y.

1. (3%) What is the MatLab statement for applying `mask` to image Y using **imfilter** to compute Y_X, where the output image Y_X is the same size as the input image Y? (We refer to this solution as Y_{X1} later.)

```
mask=[1 -8 0 8 -1]/12;
Y_X1=imfilter(Y,mask,'conv','same','symmetric');
Need to specify how border are handled. If no boundary handler is
specified values where the boundary is overlapped are set to zero.
```

2. (7%) If a vectorized solution for Y_X is required, show the **circshift** statements required and the vectorized calculation required on them to get Y_X (we refer to this solution as Y_{X2} later):

```
Yp2= 1.0*circshift(Y,[0 -2]);
Yp1=-8.0*circshift(Y,[0 -1]);
Ym1= 8.0*circshift(Y,[0 1]);
Ym2=-1.0*circshift(Y,[0 2]);


Y_X2=(Yp2+Yp1+Ym1+Ym2)/12;
```

3. (3%) What is the MatLab statement for applying `mask` to image Y using **imfilter** to compute Y_Y, where the output image Y_Y is the same size as the input image Y? Note that the mask values must be applied vertically. (We refer to this solution as Y_{Y1} later.)

```
Y_Y1=imfilter(Y,mask',’conv’,’same’,’symmetric’);
```

or

```
Y_Y2=imfilter(Y',mask,’conv’,’same’,’symmetric’);
```

4. (7%) If a vectorized solution for Y_Y is required, show the **circshift** statements required and the vectorized calculation required on them to compute Y_Y (we refer to this solution as Y_{Y2} later).

```
Yp2= 1.0*circshift(Y,[-2 0]);
Yp1=-8.0*circshift(Y,[-1 0]);
Ym1= 8.0*circshift(Y,[1 0]);
Ym2=-1.0*circshift(Y,[2 0]);

Y_Y2=(Yp2+Yp1+Ym1+Ym2)/12;
```

5. (5%) How and where do Y_{X1} and Y_{X2} and Y_{Y1} and Y_{Y2} differ from each other?

   Y_{X1} and Y_{X2}:

   They differ in the first two and last two columns. imfilter uses reflection there and vectorization uses wraparound. Note that the derivative values at the top and bottom rows are the same.

   Y_{Y1} and Y_{Y2}:

   They differ in the first two and last two rows. imfilter uses reflection there and vectorization uses wraparound. Note that the derivative values at the left and right columns are the same.

(4) (20%) Consider the following row vector `Q=[1 2 3 4 5 6 7 8 9];`

1. (5%) What does `L=Q+3<8`?

```
 1     1     1     1     0     0     0     0     0
```

2. (5%) What does `C=find(Q+3<8)` print?

```
Note that \verb!L(:)! is a 1D row vector: 1 1 1 1 0 0 0 0 0
C=find(Q+3<8) gives the 1D coordinates:
C =   1     2     3     4
```

3. (5%) What does `size(Q)` print?

```
size(Q)
     1    9
```

4. (5%) What does `sum(L(:))` compute?

```
L=Q+3<8 is  1 1 1 1 0 0 0 0 0
So L(:)' has values 1 1 1 1 0 0 0 0 0 and the sum(L(:))=4.
(Note that L(:) is a column vector)
```

```
2016 Midterm Statistics
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average for all registered students (including thos who did
not write exam):                          59.48
average just for those who wrote exam:  70.50

90+      7
85-89    4
80-84    5
75-79    9
70-74    9
65-69    4
60-64    8
55-59    3
50-54    2
40-49    5
30-39    1
```