Name: _____ NetID: _____
(Legibly print last name, first name, middle name)

Statement of integrity:

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Circle your discussion section:

Section	Day and Time	Instructor
201	W 10:10 AM - 11:00 AM	Aravind Suresh Babu & Carlos Alvarez
202	W 11:20 AM - 12:10 PM	Carlos Alvarez
203	W 12:25 PM - 1:15 PM	Dominic Diaz
204	W 1:30 PM - 2:20 PM	Dominic Diaz
205	W 2:40 PM - 3:30 PM	Xinran Zhu
206	W 3:45 PM - 4:35 PM	Xinran Zhu

Instructions:

- Check that this packet has 8 double-sided sheets.
- This is a 90-minute, closed-book exam; no calculators are allowed.
- The exam is worth a total of 100 points, so it's about one point per minute!
- Read each problem completely, including any provided code, before starting it.
- Do not modify any *given* code unless asked to do so.
- Raise your hand if you have any questions.
- Use the back of the pages if you need additional space.
- Clarity, conciseness, and good programming style count for credit.
- Indicate your final answer. If you supply multiple answers, you may receive a *zero* on that question.
- Use only MATLAB code. No credit for code written in other programming languages.
- Assume there will be no input errors.
- Write user-defined functions and subfunctions only if asked to do so.
- Do not use `switch`, `try`, `catch`, `break`, `continue`, or return statements.
- Do not use built-in functions that have not been discussed in the course.
- You may find the following MATLAB predefined functions useful: `abs`, `sqrt`, `rem`, `min`, `max`, `floor`, `ceil`, `rand`, `zeros`, `ones`, `sum`, `length`, `size`, `fprintf`, `disp`, `uint8`, `double`, `char`, `strcmp`, `str2double`, `cell`

Examples:
`zeros(1,4)` → 1 row 4 columns of zeros, type `double`
`cell(3,2)` → a 3-by-2 cell array, each cell is the empty numeric vector `[]`
`length([2 4 8])` → 3, length of a vector
`[nr,nc,np]=size(M)` → dimensions of `M`: `nr` rows, `nc` columns, `np` layers
`strcmp('cat','Cat')` → 0, the two strings are not identical
`str2double(' -2.6 ')` → −2.6, a type `double` scalar
`uint8(4.7)` → the integer (type `uint8`) value 5

Use this page for scratch work.

Question 1 (8 points)

(1.1) What is the output from executing the following fragment? Write the word "error" instead of the output if executing the fragment would cause a run-time error.

```
%       1234567890
vec = 'ABCAADAEFA';
n = length(vec);
x = 0;
for k = 1:n
    if strcmp(vec(k), 'A')
        vec(n-k+1) = 'G';
        x = x + 1;
    end
end
disp(x)
```

Output:

(1.2) What is the output from executing the following fragment? Write the word "error" instead of the output if executing the fragment would cause a run-time error.

```
M = [2 3 4 5 6 7 8; ...
     3 4 5 6 7 8 9];

[nr,nc] = size(M);
for r = nr:-1:1
    for c = 1:nc
        t = M(r,c);
        M(r,c) = M(r,nc-c+1);
        M(r,nc-c+1) = t;
    end
end
disp(M(1,:))
```

Output:

Use this page for scratch work.

Question 2 (9 points)

Consider the function `mystery` below, which has an incomplete specification. Read the function and then complete the specification by answering questions (2.1) to (2.4).

```
function x = mystery(M)
% M is a non-empty 2-d array, where each element is an integer between 1
%   and 10, inclusive.
% x is ???

vec = zeros(1,10);
[nr, nc] = size(M);

for r = 1:nr
    for c = 1:nc
        u = M(r,c);
        vec(u) = vec(u) + 1;
    end
end
% What is vec? See Question (2.1).

b = 0;
x = 0;
for k = 1:10
    if vec(k) > b
        b = vec(k);
        x = k;
    end
end
```

(2.1) Describe variable `vec`. Hint: imagine that you are writing a comment to define `vec` at the end of the nested loops—how would you define the values in `vec`?

(2.2) What is the type (class) of the return parameter `x`?

(2.3) What is the dimension of `x`? (Is it scalar, a vector, ...?)

(2.4) Complete the function specification by writing below a concise description for `x`.

Use this page for scratch work.

Question 3 (17 points)

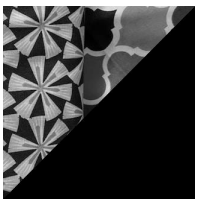
Implement the following function as specified:

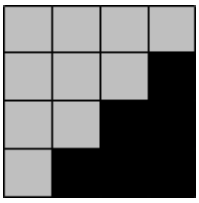
```
function Q = grayscaleTriangle(P)
% P is a non-empty 3-d uint8 array of image data. P is square: it has the
%   same number of rows and columns.
% Q is a 2-d uint8 array computed from P:
%   Q has the same number of rows and columns as P. Each pixel in the "upper
%   left triangular half" of Q has the average of the red, green, and blue
%   intensities of the corresponding pixel in P. The other pixels of Q
%   each has the uint8 value 0, corresponding to black.
% We define the "upper left triangular half" to include the minor diagonal.

[nr, nc, np]= size(P);
Q= uint8(zeros(nr,nc));
% Do not modify the code above, which assigns 0 to every element of Q.
% Add code below to assign appropriate values to the upper left triangular
% half of Q.
```

imshow(P)

imshow(Q)





Which part is the "upper left triangular half" of a matrix? In the 4×4 matrix example on the right, the elements in the upper left triangular half are gray; the other elements are black.

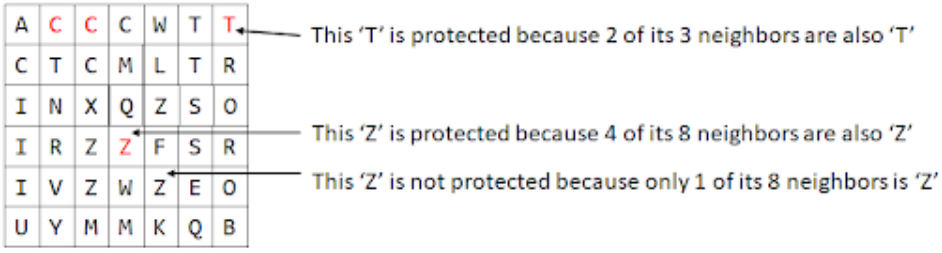
Use this page for scratch work.

Question 4 (22 points)

Implement the following function as specified:

```
function nPro = checkLetters(M)
% M is a 2-d type char matrix.  M is at least 3-by-3 in size.
% nPro is the number of "protected" characters within M. A character within
%   M is "protected" if at least half of the characters that surround it
%   are the same as itself.
```

Example: If `M` is 6-by-7 as shown below, then `checkLetters(M)` would return 4. In the diagram below, the 4 "protected" letters are shown in red.



Use this page for scratch work.

Question 5 (16 points)

Assume that a 1-d cell array `com` stores the names of some chemical compounds, one name in each cell. Find the first occurrence of two consecutive compounds that begin with the prefix '`Eth`'. Print the index of that occurrence and the names of the two compounds. If no two consecutive cells store names with the prefix '`Eth`', then print the message "not found". You can assume that all the names in `com` are at least 3 characters long. For example, if `com` is the cell array

```
{'Methane', 'Ethanol', 'Ethane', 'Butane', 'Propanol', 'Ethene'}
```

then your code should print 2, "Ethanol", and "Ethane".

For full credit, use the linear search algorithm with a `while`-loop to solve this problem. Built-in functions `find`, `strfind`, and `findstr` are forbidden.

```
% Assume 1-d cell array com, as described above, is given.  com is not empty.
% Write your code below.
```

Use this page for scratch work.

Question 6 (28 points)

For each exercise in MATLAB Grader, we get one data file containing students' per-problem scores. Here, we assume that each exercise always has exactly two problems. Each line in the file contains the data for one student: email address, problem 1 score, problem 2 score. Below is an example showing the format of the data file.

```
xyz756@cornell.edu,0.13,0.5
abc123@cornell.edu,0.3,--
ef9@cornell.edu,0.5,0
ghi18@cornell.edu,--,0.1
omg2151@cornell.edu,--,--
```

The characters '`--`' indicate that a student did not submit an answer to a problem. A student's submission is incomplete if the data for that student is '`--`' for one or both problems. Note that a 0 for a problem in the data file is not the same as incomplete. Therefore the example above indicates 2 complete and 3 incomplete submissions.

Complete the function `checkSubmissions` on the next page to parse the data file and compute each student's exercise score as specified. Assume the file has at least one line of data. If a student did not submit a problem (indicated by '`--`'), assign a numeric score of 0 for that problem.

You can add code above, below, and between the given statements, but do not cross out any given code. Built-in functions `find`, `strfind`, and `findstr` are forbidden.

Use this page for scratch work.

Question 6, continued

```
function sData= checkSubmissions(inFilename, exNum)
% inFilename names a file from which to read students' data on an exercise.
% exNum is the exercise number, an integer.
% sData is a 2-d cell array; it has 4 columns and the same number of rows
%   as the number of lines in the data file.  In each row of sData,
%   column 1 stores a student's NetID (a char vector)
%   column 2 stores the student's problem 1 score (a type double value)
%   column 3 stores the student's problem 2 score (a type double value)
%   column 4 stores the student's total exercise score (a type double value)
% Print the total number of submissions and the number of incomplete submissions.

fid= fopen(inFilename, 'r');




while ~feof(fid)


    line= fgetl(fid);
    info= textscan(line, '%s %s %s', 'delimiter',',');
    info= cellstr2str(info);  % remove nesting of cells
    % info is a 1-d cell array of length 3; each cell stores a char vector,
    %   e.g., {'abc123@cornell.edu', '0.3', '--'}
```

```
end

fprintf('Processed data for Exercise %d.', exNum)

fprintf(' %d submissions in total,', ________________)
fprintf(' %d submissions incomplete.\n',                ________________)
fclose(fid);
```

Use this page for scratch work.