

CS1112 Summer 2010

Final Exam Solutions

Print Name: _____

Problem 1	20 pts	16.5
Problem 2	15 pts	12.1
Problem 3	10 pts	5.7
Problem 4	10 pts	8.5
Problem 5	15 pts	10.5
Problem 6	10 pts	6.1
Problem 7	20 pts	14.8



Median = 81

Mean = 74

Problem 1(a). (10 points) What is the output when the following script is executed?

```
x = 10;
y = 20;
NumberOfTimesThruLoop = 1;
while x+y<=100
    z = x+y;
    x = y;
    y = z + NumberOfTimesThruLoop;
    fprintf('%3d \n',y)
end
```

Solution

```
31
52
84
```

-3 if one too many lines of output

-6 if only first or last line of output

Problem 1(b). (10 points) Assume that the value of the variable *n* is a positive integer. Rewrite the following fragment so that it uses a **while**-loop and produces exactly the same output.

```
for k=3:4:n
    fprintf('k = %3d\n',k)
end
```

Solution

```
k = 3;
while k<=n
    fprintf('k = %3d\n',k)
    k = k+4;
end
```

Initialization = 2 While condition = 2 loop body order = 3 update of k = 3

Problem 2(a). (10 points) Consider the following function:

```
function [u,v] = AddAndSubtract(x,y)
v = x+y;
u = y-x;
fprintf('u = %2d  v = %2d  x = %2d  y = %2d\n',u,v,x,y)
```

What is the output when following script is executed?

```
u = 30;
v = 10;
[y,x] = AddAndSubtract(u-v,u+v);
fprintf('u = %2d  v = %2d  x = %2d  y = %2d\n',u,v,x,y)
```

Show work.

Solution

The script calls `AddAndSubtract` with input variables `x = 20` and `y = 40`.

Local variable `v` is assigned the value 60 and `u` gets 20.

The first line of output is therefore

20 60 20 40 5 points

In the script, the function call assigns 20 to `y` and 60 to `x`. Thus, the second line of output is

30 10 60 20 5 points

Problem 2(b). (5 points) Consider the following function

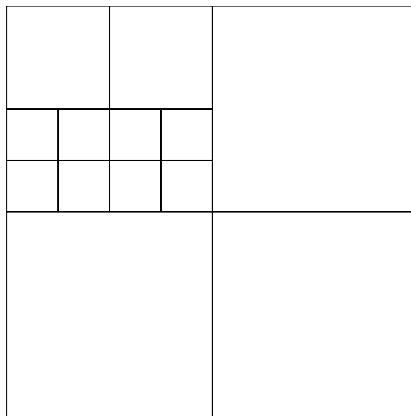
```
function DrawOrPartition(a,b,s)
disp('Calling Function')
r = rand(1);
if s<=.125 || r<.5
    plot([a a+s a+s a a],[b b b+s b+s b],'k')
else
    DrawOrPartition(a,b,s/2);
    DrawOrPartition(a+s/2,b,s/2);
    DrawOrPartition(a,b+s/2,s/2);
    DrawOrPartition(a+s/2,b+s/2,s/2);
end
```

Notice that the message 'Calling Function' is printed in the Command Window every time DrawOrPartition is called.

Now suppose that the script

```
figure
axis equal off
hold on
DrawOrPartition(0,0,1)
```

is run and that it produces the following figure:



How many times is the message 'Calling Function' printed in the Command Window? You must justify your answer to receive full credit. Hint: Draw a tree that depicts the subdivision process.

Solution:

17 is the answer = total number of squares in the image
2 points for reasonable divide-and-conquer chat

Problem 3. (10 points) The area of the largest regular polygon with n sides that fits inside the unit circle is given by

$$A_n = n \frac{c}{\sqrt{1-c^2}}$$

where

$$c = \cos\left(\frac{\pi}{n}\right)$$

Since $\cos(\pi/3) = 1/2$, we see that

$$A_3 = \frac{3\sqrt{3}}{4}$$

is the area of the largest equilateral triangle that fits inside the unit circle. Using the formula

$$\cos\left(\frac{\theta}{2}\right) = \sqrt{\frac{1 + \cos(\theta)}{2}}$$

write a script that assigns to **A** the value of A_n where $n = 3 \cdot 2^{10}$. To receive full credit, your solution must make effective use of a **for**-loop and not make use of any built-in MATLAB function.

Solution

```
c = 1/2;                2 points
for k=1:10              2 points
    c = sqrt((1+c)/2);  4 points
end
A = 3*2^10 *c/sqrt(1-c*c);  2 points
```

Problem 4. (10 points) The following script displays 100 randomly positioned unit squares in the figure window:

```
close all
figure
axis equal off
hold on
a = rand(1);
b = rand(1);
for k=1:1000
    x = rand(1);
    y = rand(1);
    plot([x x+1 x+1 x x],[y y y+1 y+1 y], 'k')
end
```

Modify the loop body so that it only displays squares that include the point (a, b) . The displayed square should be red with probability .2, green with probability .5, and blue with probability .1.

Solution

```
x = rand(1);
y = rand(1);
if x<=a && a<=x+1 && y<=b && b<=y+1           4 points
    rn = rand(1)
    if rn<.2                                     2 points
        c = 'r';
    elseif rn<=.7                               2 points
        c = 'g';
    elseif rn<=.8                               2 points
        c = 'b';
    end
    plot([x x+1 x+1 x x],[y y y+1 y+1 y],c)
end
```

OK if you displayed square as some other color the remaining 20 percent of the time

Problem 5. (15 points) The following script prints each line of the file `X.dat`:

```
fid = fopen('X.dat','r');
while ~feof(fid)
    s = fgetl(fid);
    disp(s)
end
fclose(fid)
```

Recall that the built-in function `strcmp` has the property that `strcmp(s1,s2)` is 1 if `s1` and `s2` are identical strings and 0 otherwise. Write a script that prints the last one hundred lines of `X` that begin with `'NY'`. You may assume that at least one hundred lines of `X` begin with `'NY'`.

Solution

```
fid = fopen('X.dat','r');
k = 0
while ~feof(fid)
    s = fgetl(fid);
    if strcmp('NY',s(1:2))    8 points for setting up C or equivalent
        k = k+1;
        C{k} = s;
    end
end
fclose(fid)
for j=k-99:k                7 points for displaying the last 100 NY strings
    disp(C{j})
end
```

There are other solutions

- (1) Read all strings into cell array. Count the number of NY strings. Print last 100
- (2) Count number of NY strings as you read the file. Then read the file again and print out NY strings if they are one of the last 100.

Problem 6. Assume the availability of the following functions

```
function P = MakePoint(x,y)
% x and y are real numbers and P represents the point
%   with Cartesian coordinates (x,y).
% P.x is the x-coordinate and P.y is the y-coordinate
  P = struct('x',x,'y',y);
```

```
function T = MakeTriangle(A,B,C)
% T represents a triangle with vertices A, B, and C
% that are distinct points.
  T = struct('A',A,'B',B,'C',C);
```

(a) (5 points) Suppose F is a triangle. Complete the following command so that F is displayed as a colored blue triangle:

```
fill([F.A.x F.B.x F.C.x ], [F.A.y F.B.y F.C.y], 'b')
```

```
-3 for fill([A.x B.x C.x ], [A.y B.y C.y], 'b')
```

(b) (5 points) Complete the following function so that it performs as specified:

```
function T = ListOfTriangles(P)
% P is a length-n structure array of points. It is assumed that
%   P(1),...,P(n) are distinct and situated on the unit circle.
% T is a structure array consisting of all possible triangles
%   that have vertices chosen from P(1),...,P(n). Each triangle
%   in T must have positive area and no two triangles in T
%   should be the same.

n = length(P);
q = 0;
for i=1:n
    for j=i+1:n
        for k=j+1:n
            q = q+1;
            T(q) = MakeTriangle(P(i),P(j),P(k));
        end
    end
end
```


Problem 7(a). (10 points) Complete the following function so that it performs as specified:

```
function [vMax,j] = maxV(v)
% v is a vector with distinct values.
% vMax is the maximum value in v and j is an integer with the
% property that the value of v(j) is vMax.
```

You are NOT allowed to use the built-in function `max`.

Solution

```
n = length(v);           Initializations = 2 points
vMax = v(1);
j = 1;
for i=2:n                Loop = 2 points
    if v(i)>vMax          condition 3 points
        vMax = v(i);    updates 3 points
        j = i;
    end
end
```

Problem 7(b). (10 points) Assume that `vMax` is correctly implemented and available. Complete the following function so that it performs as specified:

```
function [AMax,p,q] = maxA(A)
% A is a matrix with distinct values.
% AMax is the maximum value in A and p and q are integers with the
% property that the value of A(p,q) is AMax.
```

Your implementation must make effective use `vMax` and must NOT use the built-in function `max`.

Solution

```
[m,n] = size(A);
[AMax,p] = vMax(A(:,1));           % Initialization = 2 points
for j=2:n
    % Can we do better in column j?
    [vMax,i] = vMax(A(:,j));      % applying vMax    3 points
    if vMax > AMax                % 1 point
        % Remember the new maximum % 1 point
        AMax = vMax;              % 1 point
        q = j;                    % its column index % 1 point
        p = i;                    % its row index    % 1 point
    end
end
```