CS1115 Lab 4 (September 19, 2013)

Completing the lab is very important, but your work is not graded and it is not submitted. If you finish before the hour is over, then you can leave early or you can work on the "Finished Early" problems. If you do not finish the problems before the end of class, then be sure to ask enough questions so that you can complete the exercises in the next day or two on your own.

1 Different ways to create vectors

Type the following expressions in the MATLAB *Command Window* to see what kind of vectors they create. Write the resulting vectors (and answer the questions) on the blanks.

```
a= zeros(1,4)   %_____

b= zeros(4,1)   %_____      What do the arguments specify?_____

c= ones(1,3)    %_____

d= 10:2:17      %_____

f= 10:-1:17     %_____

g= [10 20 40]   %_____      What does the space separator do?_____

h= [10,20,40]   %_____      What does the comma separator do?_____

k= [10;20;40]   %_____      What does the semi-colon separator do?_____

m= [a g]        %_____

n= [b; k]       %_____

p= [a k]        %ERROR--mismatched dimensions! (Attempt to concatenate a column to a row)

q= b'           %_____      This operation is called "transpose"

r= [a b']       %_____
```

2 Built-In Functions and Vectors

Using `help` and the following small examples, figure out what the built-in functions do: `rand`, `randn`, `max`, `min`, `sum`, `sort`

```
x = rand(1,4)
x = rand(4,1)
y = randn(1,4)
s = sum(y)
M = max(y)
[M,i] = max(y)
m = min(y)
[m,i] = min(y)
z = sort(y)
```

Describe in English what the following commands do, assuming that `x` is an initialized vector. Check out your reasoning by running the commands on small examples.

```
y = x - sum(x)/length(x)                % Example 1

y = sqrt(sum(((x + abs(x))/2 ).^2)      % Example 2

t = sum(sin(x).^2 + cos(x).^2)/length(x)  % Example 3
```

3 Plotting Relative Error

From the syllabus page, download `MySqrt` and `MySqrtErr`.

```
% Script MySqrtErr
n = 1000;
x = logspace(0,6,n);
relErr = zeros(1,n);
for k=1:n
    Approx = MySqrt(x(k));
    True   = sqrt(x(k));
    relErr(k) = abs(True - Approx)/True;
end
loglog(x,relErr,'.')
axis([a b 10^-18 10^1])
shg

function s = MySqrt(A)
% A is a positive real scalar
% s is an approximation to its square root
L = A; W = 1;
for k=1:10
    L = (L+W)/2;
    W = A/L;
end
s = L;
```

(0) Run `MySqrtErr`. (1) Play with the loop bound in `MySqrt` and observe the effect. (2) How does `logspace` work? What is `logspace(-3,4,8)`? What is `logspace(0,1,2)`? (3) Instead of `loglog`, what if we used `plot`? What if we used `semilogy`? (4) In MATLAB, `eps` is a built-in constant. What is it? Modify `MySqrt` so that the averaging process runs until `abs(L-W)/L < eps` and rerun the original `MySqrtErr`. (5) Play with the `axis` command and figure out what `axis(v)` does where v is a length-4 vector. (6) Figure out what `shg` does by removing it from `MySqrtErr` and then running the resulting script.

4 Finished Early?

The number ways a set of n objects can be partitioned into m nonempty subsets is given by

$$\sigma_n^{(m)} = \sum_{j=1}^{m} \frac{(-1)^{m-j} j^n}{(m-j)!j!}.$$

It is not obvious but the summation always renders an integer as long as $1 \leq m \leq n$. For example,

$$\sigma_4^{(2)} = \frac{(-1)^{2-1}1^4}{(2-1)!1!} + \frac{(-1)^{2-2}2^4}{(2-2)!2!} = -1 + 8 = 7.$$

Thus, there are 7 ways to partition a 4-element set like $\{a, b, c, d\}$ into two non-empty subsets:

$$
\begin{array}{ccl}
1 & : & \{a\},\{b,c,d\} \\
2 & : & \{b\},\{a,c,d\} \\
3 & : & \{c\}, \{a,b,d\} \\
4 & : & \{d\},\{a,b,c\} \\
5 & : & \{a,b\},\{c,d\} \\
6 & : & \{a,c\},\{b,d\} \\
7 & : & \{a,d\},\{b,c\}
\end{array}
$$

Note that $\sigma_n^{(1)} = \sigma_n^{(n)} = 1$. Implement a function `Subset(n,m)` that returns the value of $\sigma_n^{(m)}$. Use `Subset` to print a table with 10 lines. On line n should be printed the numbers $\sigma_n^{(1)}, \sigma_n^{(2)}, \ldots, \sigma_n^{(6)}$.

Please delete your files from the computer before you leave the lab!