

Problem 5 - MATLAB

Problem 5a: Dot Product of Two Vectors (in MATLAB)

```
clear all;

n = 10000; % Length of the vectors
a = rand(n,1); % Create a random column vector a
b = rand(n,1); % Create a random column vector b

c = 0;

% Dot product with for-loop
tic
for i = 1:n
    c = c + a(i)*b(i);
end
timeloop = toc;
c;

% Dot product with vectorization
tic
cc = a.'*b;
timevec = toc;
cc;

% Compare the results
fprintf("norm: %f",norm(c-cc))

% Measure the speed-up
Speedup = timeloop/timevec;

fprintf("\nSpeedup: %f\n", Speedup);
```

Output:

```
>> p5_vv_prod
norm: 0.000000
Speedup: 24.254700
```

Problem 5b: Matrix-Vector Product

```

clear all;

n = 100;

A = rand(n,n); % Matrix
x = rand(n,1); % vector

b = zeros(n,1);
bb = zeros(n,1);

% For-loop
tic
for i = 1:n
    for j=1:n
        b(i) = b(i) + A(i,j)*x(j);
    end
end
timeloop = toc;

% Loop Vectorization
tic
for i = 1:n
    bb(i) = A(i,:)*x;
end
timeloopvec = toc;

% vectorization
tic
bbb = A*x;
timevec = toc;

fprintf("norm 1: %f", norm(b-bb))
fprintf("\nnorm 2: %f\n", norm(b-bbb))

Speedup = timeloop/timeloopvec;
Speedup2 = timeloop/timevec;
Speedup3 = timeloopvec/timevec;

fprintf("\nSpeedup: %f\n", Speedup);
fprintf("\nSpeedup 2: %f\n", Speedup2);
fprintf("\nSpeedup 3: %f\n", Speedup3);

```

Output:

```
>> p5_mv_prod
norm 1: 0.000000
norm 2: 0.000000

Speedup: 0.532860
|
Speedup 2: 0.359525

Speedup 3: 0.674709
```

Problem 5c: Matrix-matrix Product

```
clear all;
n = 1000;
A = rand(n,n); % Matrix A
B = rand(n,n); % Matrix B

C = zeros(n,n);
CC = zeros(n,n);

% For-loop
tic
for i = 1:n
    for j=1:n
        for k=1:n
            C(i,j) = C(i,j) + A(i,k)*B(k,j);
        end
    end
end
timeloop = toc;

% Loop Vectorization
tic
for j = 1:n
    CC(:,j) = A*B(:,j);
end
timevec = toc;

% vectorization
tic
CCC = A*B;
timevec = toc;
```

```

fprintf("norm 1: %f", norm(C-CC))
fprintf("\nnorm 2: %f\n", norm(C-CCC))

Speedup = timeloop/timeloopvec;
Speedup2 = timeloop/timevec;
Speedup3 = timeloopvec/timevec;

fprintf("\nSpeedup: %f\n", Speedup);
fprintf("\nSpeedup 2: %f\n", Speedup2);
fprintf("\nSpeedup 3: %f\n", Speedup3);

```

Output:

```

>> p5_mm_prod
norm 1: 0.000000
norm 2: 0.000000
|
Speedup: 41.162785

Speedup 2: 255.464763

Speedup 3: 6.206207

```