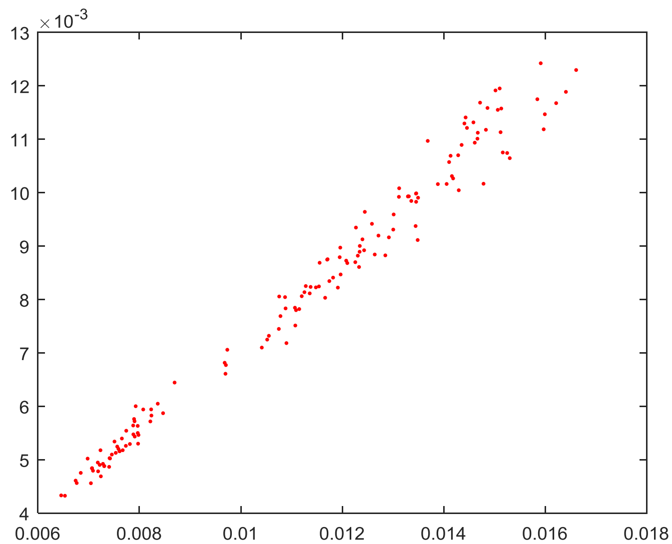
HW0

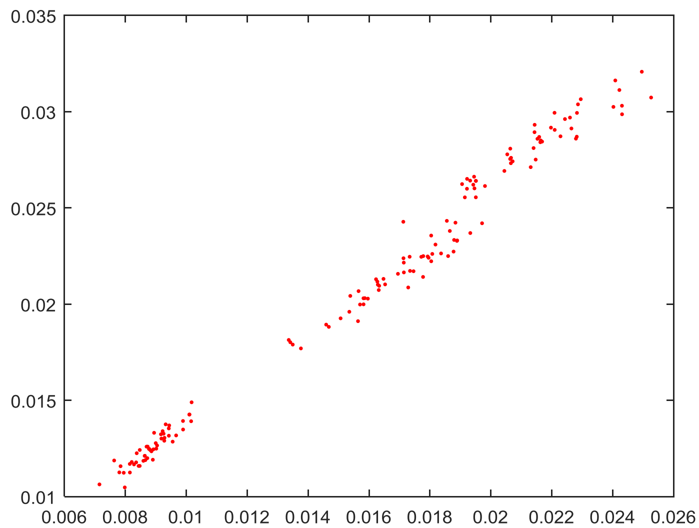
<u>Problem 1:</u>

```
function R = projection(A, k)

p = size(A, 2);
P = rand(p, k);

colsums = sum(A, 1);
for i = 1:p
    A(:,i) = A(:,i) ./ colsums(i);
end
R = A * P;
```

Iris:

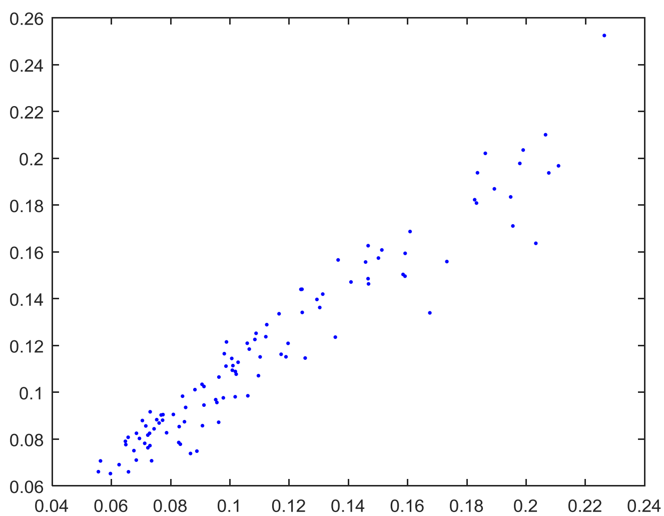


Outliers: `Xprojected(I1, :) = 0.0166     0.0123`

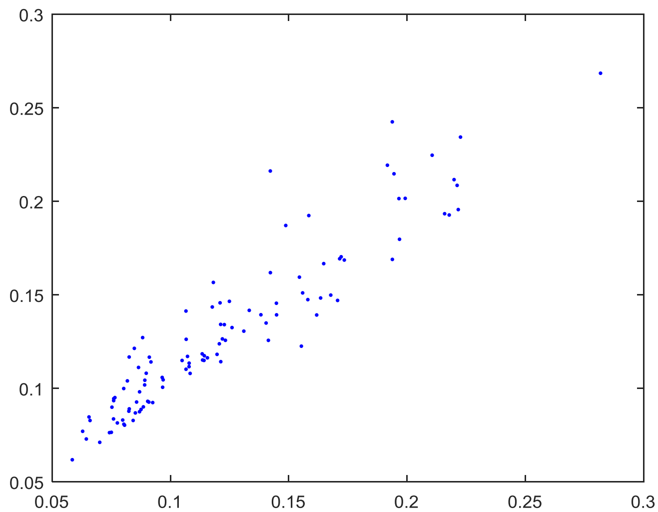


Outliers: `Xprojected(I1, :) = 0.0250     0.0321`

HallOfFame:



Outliers: `Yprojected(I2, :) = 0.2264     0.2524`

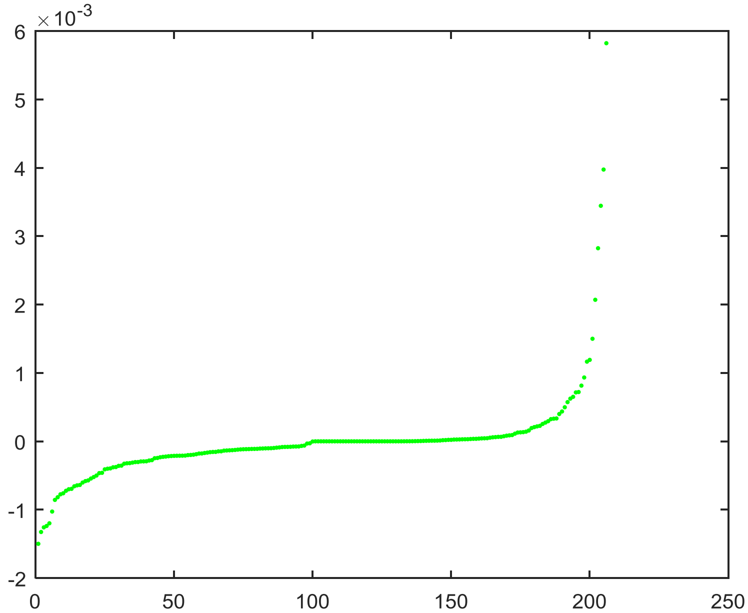


Outliers: `Yprojected(I2, :) = 0.2818     0.2685`

Problem 2:

1.

```
heroes;
[V, E] = eig(hero_network);
e = diag(E);

plot(e, 'g.');
```

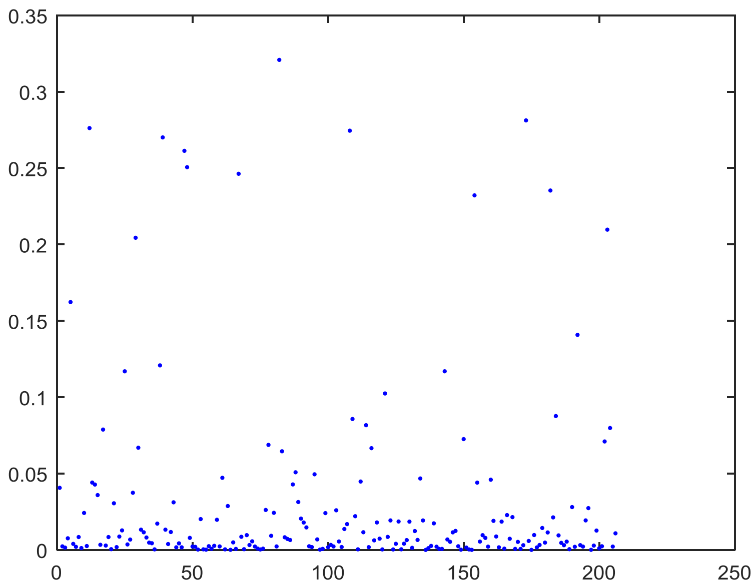


2.
```
[largest, index] = max(e);
spectralnorm = norm(hero_network)
```

Yes, the largest eigenvalue is equal to the spectral norm = 0.0058

3.
```
eigenvector = V(:,index) %print eigenvector corresp to largest eigenvalue
plot(eigenvector, 'b.');
```

The eigenvector corresponding to the largest eigenvalue is nonegative.

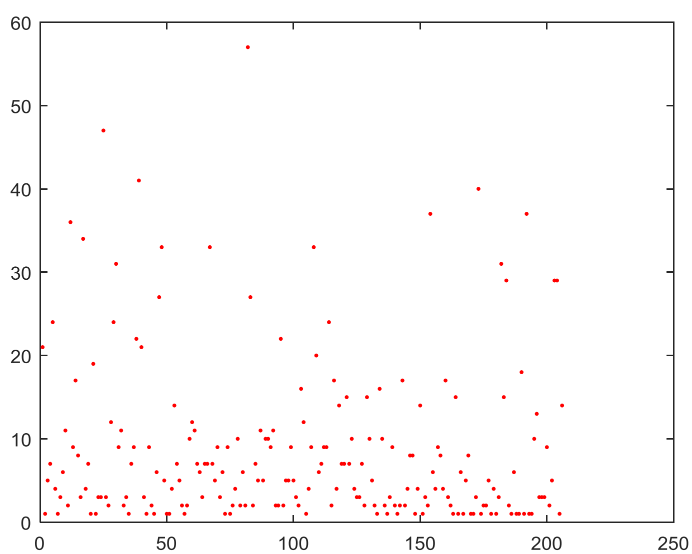



```
%find entry with largest value in eigenvector:
[largest, index] = max(eigenvector);
names(index)
```

Index = 82, so the 82nd superhero corresponds to the max value in the eigenvector with the largest eigenvalue.
Printing names(index) shows that the 82nd superhero is Captain America.

4.

```
%degree sequence
Nonzero_entries = logical(hero_network);
d = sum(Nonzero_entries, 2)
plot(d, 'r.');
```



```
[largest, index] = max(d);
index = 82
```

The 82nd superhero has the largest value. This corresponds to Captain America. The results match the result from the eigenvalue & eigenvector analysis.

5.

```
D = diag(d);
L = D - Nonzero_entries;
eigenvals = eig(L);
for i=1:size(eigenvals, 1)
    if abs(eigenvals(i)) < 1e-14,
        eigenvals(i) = 0;
    end
end

z = ~logical(eigenvals);
numzeros = sum(z)
```

There are no zero eigenvalues, using the threshold 1e-14.

6.

```
%Perron-Frobenius
colsums = sum(hero_network, 2) %sum cols of adjacency matrix
mincols = min(colsums)
maxcols = max(colsums)

The min is 8.8778e-05, max is 0.0136. The max eigenvalue is 0.0058, which is
between those two values. The theorem holds.
```

<u>Problem 3:</u>

1.

```
%Jacobi function
function [V, L] = jacobi(A)
n = size(A, 1);
V = eye(n);

offDiag = logical(1-eye(n));

while (norm(A(offDiag), 'fro')^2/norm(A, 'fro')^2 > n*n*eps)
    max = -Inf;
    %choose p, q so |A(p, q)| is maximized
    for p = 1:(n-1)
        for q = (p+1):n
            curr = abs(A(p, q));
            if curr > max,
                max = curr;
                maxp = p;
                maxq = q;
            end
        end
    end

    [c, s] = symschur2(A, maxp, maxq);
```

```
    J = eye(n);
    J(p, p) = c; J(p, q) = s; J(q, p) = -s; J(q, q) = c;
    A = J'*A*J;
    V = V*J;
end

L = diag(diag(A));

%---------------------------------------------
%rotation function
function [c, s] = symschur2(A, p, q)

if A(p, q) ~= 0,
    t = (A(q, q) - A(p, p)/(2*A(p, q)));
    if t >= 0,
        t = 1/(t + sqrt(1+(t^2)));
    else
        t = -1/(-t + sqrt(1+(t^2)));
    end
    c = 1/sqrt(1+(t^2));
    s = t*c;
else
    c = 1;
    s = 0;
end
```