

MATH 256
EigenLab
Nov 21, 2016

Name: _____

Name: _____

Pair up with someone (it is more fun that way). Visit these resources and answer the questions below. For convenience, there are direct links from the MATH 256 course webpage so you do not need to type in the web addresses. Visit the following website from **Cornell University**:

<http://www.math.cornell.edu/~mec/Winter2009/RalucaRemus/Lecture3/lecture3.html>.

Read up to and including the section that says **Linear Algebra point of view**. Of course, you can keep reading if you want! Answer the questions below.

1. Explain the difference(s) between *text based ranking* and the *page rank algorithm*. Why is the page rank algorithm so much better than text based?

2. Look carefully at the matrix $A = \begin{bmatrix} 0 & 0 & 1 & \frac{1}{2} \\ \frac{1}{3} & 0 & 0 & 0 \\ \frac{1}{3} & \frac{1}{2} & 0 & \frac{1}{2} \\ \frac{1}{3} & \frac{1}{2} & 0 & 0 \end{bmatrix}$. Here, you are asked to explain clearly the contents of A .

(a) What is the meaning of column $\mathbf{a}_4 = \begin{bmatrix} \frac{1}{2} \\ 0 \\ \frac{1}{2} \\ 0 \end{bmatrix}$ and the entries within it? And $\mathbf{a}_1 = \begin{bmatrix} 0 \\ \frac{1}{3} \\ \frac{1}{3} \\ \frac{1}{3} \end{bmatrix}$?

(b) What is the meaning of the row vector $\mathbf{r}_3 = \left[\frac{1}{3} \quad \frac{1}{2} \quad 0 \quad \frac{1}{2} \right]$ and its entries?

3. How is all of this related to the eigenvalue problem $A\mathbf{x} = \lambda\mathbf{x}$?

4. What is the meaning of the eigenvector \mathbf{x} in this context?

5. Why is $\lambda = 1$?

6. Based on the discussion and the graph with vertices, it appears that any of the following—Page1, Page3, or Page4—could emerge the victor (i.e., appear at the top of a Google search). So why does Page1 end up winning?

7. Visit the **Setosa** (<http://setosa.io/ev/eigenvectors-and-eigenvalues/>) site. This has some nice visualizations. You should read/play around on the site up to and including the section, “What are Eigenvalues/vectors good for?” How is this last section and the accompanying graphic similar to the earlier discussion on Page Rank?

Other sources:

<http://www.ams.org/samplings/feature-column/fcarc-pagerank> (a little more advanced than the Cornell page but still interesting)