

**Problem 2.** Reproduce the definitions from the reading of the following terms below. (Your midterm quiz will be to reproduce these definitions exactly.)

1. irreducible matrix

the graph shows that every node is reachable from every other node

(there are other equivalent definitions of irreducible, but you do not need to know them.)

2. primitive matrix

a non-negative, irreducible matrix is primitive if it has only one eigenvalue on its spectral circle

3. aperiodic markov chain

An irreducible Markov chain with a primitive transition matrix

4. P

a square  $n \times n$  matrix whose element  $p_{ij}$  is the probability of moving from state  $i$  (page  $i$ ) to state  $j$  (page  $j$ )

5.  $\bar{P}$

replace all zero rows in  $P$  with  $\frac{1}{n}e^T$ ,

where  $e^T$  is the row vector of all ones

6.  $\bar{P} = \alpha \bar{P} + (1-\alpha) \frac{ee^T}{n}$  (no personalization vector)

or

$$= \alpha \bar{P} + (1-\alpha) \frac{ev^T}{n} \quad (\text{with personalization vector})$$

7.  $\pi$  pagerank vector

the stochastic vector which is the top eigenvector of  $\bar{P}$

8.  $v$  personalization vector

a stochastic vector chosen by the user