

**Problem 1. [15 points]** Use the web graph below to answer parts (a), (b), and (c) of this question. The pagerank of vertex  $i$  can be written as  $p_i$ . Assume each webpage starts out with a million dollars.

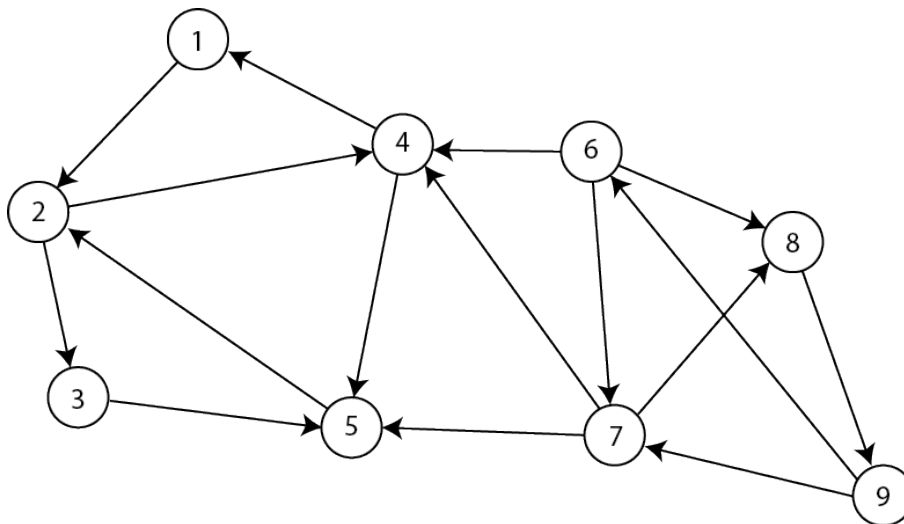


Figure 1: Web Graph

(a) [6 pts] Compute the first two iterations of PageRank, starting from uniform PageRank values of a million across all vertices.

(b) [5 pts] For  $\vec{p}'$  in terms of  $\vec{p}$  can be written as a matrix product:  $\vec{p}' = W\vec{p}$ , for some matrix  $W$ , which is the *update matrix*. Find the update matrix.

(c) [5 pts] Calculate the stationary values for the web graph.