

# Homework 7

**Student Number:**

**Name:**

**Problem 1.** (20 points) Is it always possible to follow directed edges (hyperlinks) in the web graph from any node (web page) to any other? Why or why not?

**Problem 2.** (30 points) Write down the transition probability matrix for the example in following figure. What is the steady-state visit rate for each of the states?

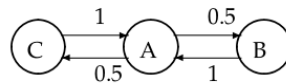


Figure 1: A simple Markov chain with three states; the numbers on the links indicate the transition probabilities.

**Problem 3.** (30 points) Consider a web graph with three nodes 1, 2 and 3. The links are as follows:  $1 \rightarrow 2$ ,  $3 \rightarrow 2$ ,  $2 \rightarrow 1$ ,  $2 \rightarrow 3$ . Write down the transition probability matrices and solve for the long-term visit rate for the nodes assuming the following three values of the teleport probability: (a)  $\alpha = 0$ ; (b)  $\alpha = 0.5$  and (c)  $\alpha = 1$ .

**Problem 4.** (20 points) Show that for any directed graph, the Markov chain induced by a random walk with the teleport operation is ergodic.