Python's Random Number Generator and Bernoulli Trials

Location of Particle Determined by Bernoulli Random Variables

(Simple Markov Process)

EE 381 – Project 3, 5 Points

Date Due: 2/24

Introduction: A Bernoulli random variable (RV) is one of the basic RV a person studying probability should be familiar with. A direct application of the random number generator available in Python allows for the simulation of Bernoulli random variables. Further, Bernoulli RV can be used to model a real world probabilistic entity such as flipping a coin.

Suppose that a trial, or an experiment, whose outcome can be classified as either a "success" or as a "failure" is performed. If we let X equal 1 if the outcome is a success and 0 if it is a failure, then the probability mass function of X is given by

$$p(0) = P[X = 0] = 1 - p$$

$$p(1) = P[X = 1] = p$$

where p, $0 \leq p \leq 1$, is the probability that the trial is a "success".

A random variable X is said to be a Bernoulli random variable if its probability mass function is given by the above for some $p \in [0,1]$.

Part 1, Bernoulli R.V.

Write a program in Python that simulates a Bernoulli RV. The program should prompt the user to input the probability of success and the number of trials (experiments) to be performed. The program should output a 1 for success or a 0 for failure depending on the outcome of the RV. Use Pythons random number generator. Possible code would be: r = random.uniform(0,1).

Part 2, Discrete Markov Chain

There are two points labeled 0 and 1 on a plane that will be referred to as nodes. Further there exists a particle. This particle can be located either at node 0 or node 1. When the particle is located at node 0 its future behavior is governed by random variable (RV) A. The RV A is a Bernoulli RV. The particle can stay at node 0 with probability $1 - p$ and it can go to node 1 with probability p. When the particle is located at node 1 its future behavior is governed by the Bernoulli RV B. The particle will stay at node 1 with probability $1 - q$ and will go to node 0 with probability q. This behavior can be presented diagrammatically.
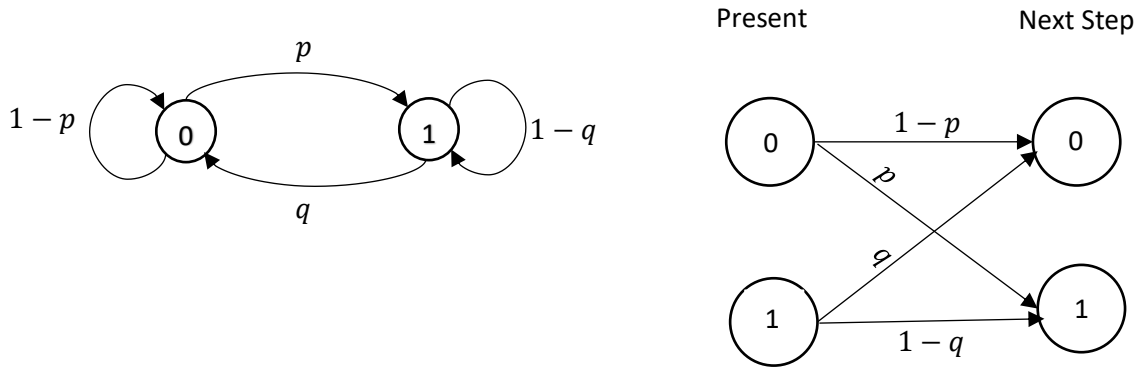
Without delving too deeply into the theory of the behavior of such a system is it possible to write a computer program that effectively simulates the behavior of the system? Consider yourself to be the particle with two coins A and B. When you are at node 0 you flip coin A and when you are at 1 you flip coin B. You'll need a random number generator over [0, 1). When at a node the Bernoulli RV will dictate how you proceed. Whether moving from node 0 to node 1 or vice versa we'll refer to this as a step. Likewise if you remain at a node, because of the outcome of the Bernoulli RV, this will be referred to as a step.

Instructions:

1.) Write a program in Python that simulates the behavior of the particle discussed above. The values of the parameters p and q will be inputted by the user. The particle can start at a random location or the user can input the starting position. Have it go through 25 steps (this includes the first step). The output should show the steps on the nodes the particle goes through. Try the following inputs and note the results.

a.) $p = q = 0$
b.) $p = 1 - q$
c.) $p = q = 1$
d.) $0 < p < 1$ and $q = 1$
e.) $0 < p < 1$ and $0 < q < 1$

During the laboratory meetings of 2/19 and 2/24 a program in Python that meets the above requirements will be written.

Deliverables: The students will make a PDF version of the two programs and submit both their Python file and the PDF with name and ID # to dropbox.