Python’s Random Number Generator and Bernoulli Trials

Location of Particle Determined by Bernoulli Random Variables

(Simple Markov Chain)

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”.

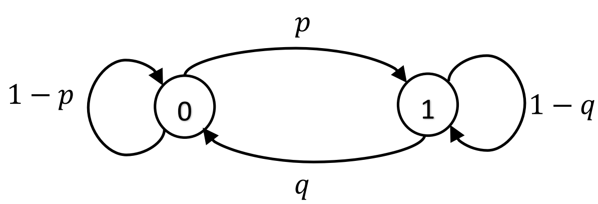
A random variable X is said to be a Bernoulli random variable if its probability mass function is given by the above for some $p \in [0,1]$.

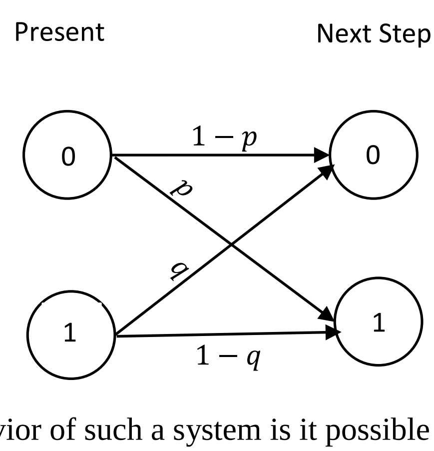
Bernoulli R.V.

A program in Python that simulates a Bernoulli RV is provided with this outline. The program prompts the user to input the probability of success and the number of trials (experiments) to be performed. The program outputs a 1 for success or a 0 for failure depending on the outcome of the RV.

Part 2, Discrete Markov Chain

There are two points labeled 0 and 1 on a plane that will be referred to as states. Further there exists a particle. This particle can be located either at state 0 or state 1. When the particle is located at state 0 its future behavior is governed by random variable (RV) A. The RV A is a Bernoulli RV. The particle can stay at state 0 with probability $1 - p$ and it can go to state 1 with probability p. When the particle is located at state 1 its future behavior is governed by the Bernoulli RV B. The particle will stay at state 1 with probability $1 - q$ and will go to state 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 state 0 you flip coin A and when you are at 1 you flip coin B. When at a state the Bernoulli RV will dictate how you proceed. Whether moving from state 0 to state 1 or vice versa we'll refer to this as a step. Likewise, if you remain at a state, because of the outcome of the Bernoulli RV, this will be referred to as a step.

A program in Python that simulates the behavior of the particle discussed above is provided with this outline. The values of the parameters p and q are inputted by the user. The output shows the states 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 $0 < q < 1$