Lecture 36: Monte Carlo Simulations

Monte Carlo Simulations

- class of computational algorithms for simulating the behavior of physical and mathematical systems.
    - often used to find solutions to mathematical problems that cannot easily be solved analytically.

- distinguished from other simulation methods by being *stochastic*, usually by using random numbers.

A Generic Problem

- Given a probability of success *p*. How many times must I execute and event before I achieve one success.

- We simulate the success using a uniform random number generator:
    - Let ***event=rand(1)***
    - if ***event<=p*** you have a success.
    - If ***event>=p*** you have a failure.

- Use the same methodology if more than 1 success is desired. by continuing the experiment until the desired number of successes is reached.

- Finally run an experiment *m* times. Each time count the number of events required to obtain *n* successes.

- Store the results in an events vector called i.e. event. I can than produce the following
    - mean=***average(event)*** %mean value of # of events required for n successes.
    - standard deviation = ***std(event)***
    - ***hist(event,1:max(event))***
- Yahtzee problem.

A Snippet of MATLAB Code

- Here is a snippet of code used to conduct *m* experiments that calculate the number of trials required to obtain *n* successes with a probability of success *p*
- Note that initialization and output statements are not shown here.

```
for i=1:m;
   success=0; % initialize number of successes
   trail=0; %initialize number of trials
   while success<n; %loop until n successes achieved.
      trail=trail+1; %trials increase by one;
      test=rand(1); %Monte Carlo simulation of event.
      if test<=p, %test for success.
         success=success+1; %successes increase if successful
      end
   end
   event=[event,trail]; %augment event vector
end
```

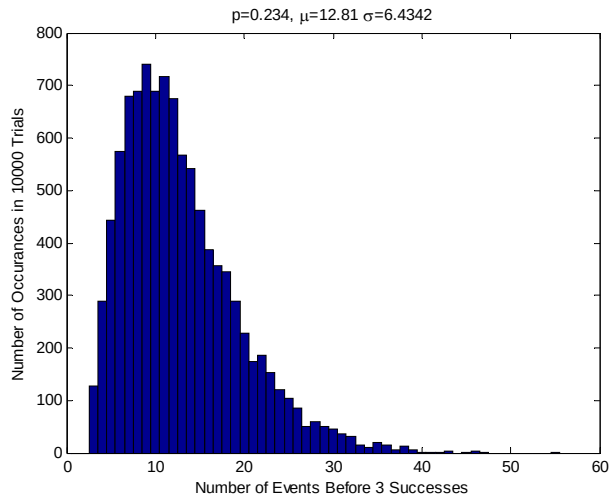
Homework 36

Write a program with the following specifications:

> ***[avg,sd]=Monte_Carlo(p,n,m)*** a Monte Carlo simulation calculates the number of times an event must occur before *n* successes are obtained given a probability of success *p*. *m* trials are conducted
>
> Input: p - probability of success.
> n - number of successes desired.
> m - number of trials conducted.
>
> Output: avg - mean of number of events required to obtain n successes.
> sd - stadard deviation of same.
> event - vector m elements long listing the number of trials required in each experiment.
> histogram of event.

Answer the following:

1. A new missile has been developed to be used against our aircraft carries. The probability of hit is .35. It is estimated that eight hits are required to neutralize an aircraft carrier. Conduct 1000 experiments and which the number of launches is determined to achieve a mission kill on the carrier. Determine the average number of launches required and the standard deviation for each experiment. Plot the results in a histogram.



2. In response to the new threat, we have developed a defensive system that reduces to probability of hit to .125. Additionally, it new takes 10 hits for a mission kill. Determine the average number of launches required and the standard deviation for each experiment. Plot the results in a histogram.

Turn in code, answers to 1 and 2, and histograms in a word file.