

CAP 4800/5805 Computer Simulation Concepts

Lecture 6

Random variables

- Probabilistic measures are important to simulation since it is often possible to define the frequency associated with some dynamical process.
- A random variable can have a range of possible values where a value is called a random number (RN)
- RN is obtained by sampling the distribution that defines the random variable.
- *Discrete* or *Continuous*
- A random variable differs from a variable

Operation	Variable	Random variable
get	$X \rightarrow \text{value}$	Sample $X \rightarrow \text{value}$
store	$X \leftarrow \text{value}$	$X \leftarrow \text{function with value range}$

- get: obtain the value of a variable
- store: put a new value into a variable

Generation random numbers (RN)

- Uniform distribution: a probability distribution function that is flat or constant across the range of values that a random variable will assume.
- For instance, to generate random numbers in the range $[0,1)$ for a uniform distribution function, we would expect any number in $[0,1)$ to be likely as any other number when a number is picked
- If we know how to generate random numbers $u \in [0,1)$ and we desire a uniform random distribution between A and B, we can generate y from u by the following

$$y = A + (B - A) u, \text{ where } y \in [A,B) \text{ and } u \in [0,1)$$

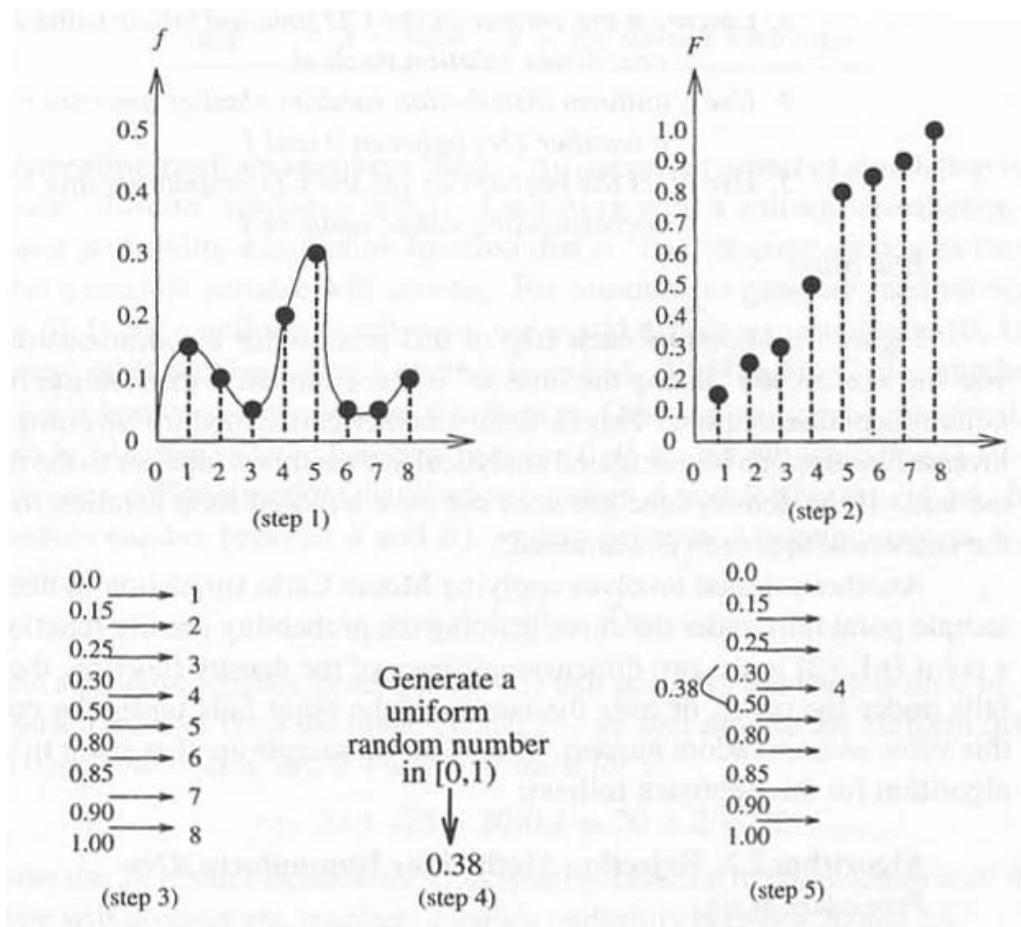
Nonuniform random number generation

- **Inverse Method for Nonuniform RNs**

Procedure Main

- 1a. Specify the nonuniform distribution
- 1b. Discretize distribution if it is continuous
(using a sampling method)
2. Create a cumulative distribution (CD) from the discrete distribution
3. Calculate the inverse of the CD function either using a table
or a direct solution method
4. Use a uniform distribution random number generator to generate
a number (N) between 0 and 1
5. Use N as the probability for the CD probability and locate the
corresponding range value in T

End Main

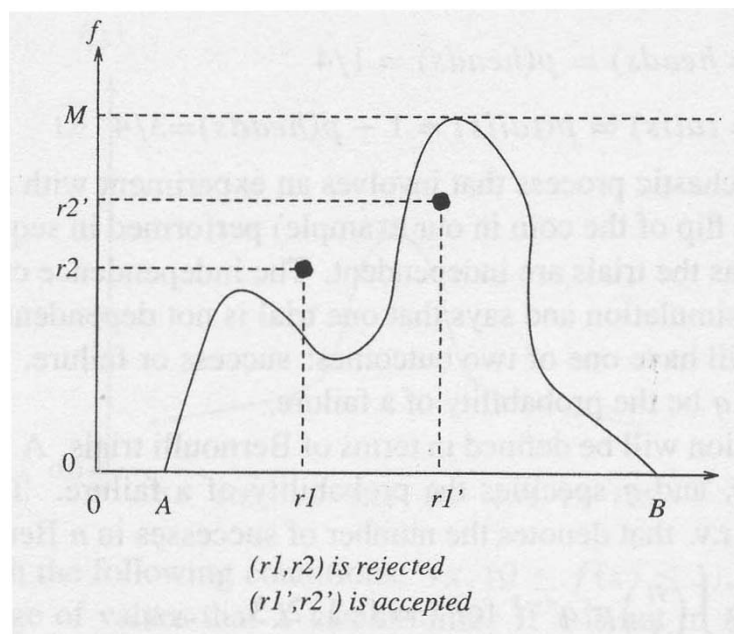


- **Rejection Method for Nonuniform RNs**

Procedure Main

- 1a. Specify the nonuniform distribution f
- 1b. Discretize distribution if it is continuous
(using a sampling method)
2. Let f be bounded by a maximum value M
3. Generate a pair of uniform random numbers $(r1, r2)$
- 3a. $r1$ is generated on a finite interval $[A, B]$ (horizontal axis)
- 3b. $r2$ is generated on a finite interval $[0, M]$ (vertical axis)
4. If $r2 < f(r1)$ then accept $r1$ and output $r1$
Else reject $r1$ and go to step 3

End Main



Fuzzy number

See additional note