

COMPUTER SIMULATIONS

A Computer simulation is the technique of conducting experiments on a computer using mathematical models which take into account the factors of a real system, in order to predict the outcome of certain events or to control these events. Thus computer simulations imitate physical processes. Computer simulation output can be numerical or graphical or both.

The first stage in the design of a simulation is to make a mathematical model of the process. Two types of models can be used to describe a process. A **deterministic** model, in which everything is predicted exactly by the math model (formulae) or a **probabilistic** model, where something depends on chance (probability).

If an object is thrown vertically with initial velocity u the distance d travelled in time t is given by

$d = ut - \frac{1}{2}gt^2$ where g is acceleration due to gravity. This is a deterministic model. This model could help us simulate the motion of a rocket.

The operation of flipping a coin can be simulated by a probabilistic model. Mathematically the model of the process can be written $P(H) = .5$ $P(T) = .5$

GENERATING RANDOM NUMBERS:

Format: `Random r = new Random();`

<code>r.Next(7);</code>	0-6
<code>r.Next(1,7);</code>	1-6
<code>r.Next(6)+1</code>	1-6

Generalization

To generate any integer number between x and $y \Rightarrow$ `r.Next(y-x+1) + x`

THE RND FUNCTION - YOUR TURN

Generate the following random numbers.

- a) $1 \leq R \leq 10$
- b) $3 \leq R \leq 17$
- c) Even numbers between 0 and 10
- d) Odd numbers between 1 and 9

ANSWERS

- a) `r.Next(1,11);`
- b) `r.Next(15)+3;`
- c) `r.Next(6)*2;`
- d) `r.Next(5)*2 +1;`

PROGRAMMING PROBLEMS:

1. Suppose two players are playing a game in which each one moves his/her chip a certain number of times, depending on where the dial stops on a spinner. The dial may stop at any number from 1 to 9 inclusive. Write a program that determines which player made the greatest number of moves after each one had 10 plays.
 - a) Use a **for/next** loop to control the number of plays
 - b) Generate a random number from 1 to 9 for the first player. This represents the number of moves he/she can make. Immediately following this statement, accumulate the player's moves.
 - c) Do the same for the second player.
 - d) After 10 plays, find the winner by comparing the accumulated moves of the two players.
 - e) Print the winner as show in the sample **run**.

PLAYER 1 IS THE WINNER
WITH A TOTAL OF 52 MOVES

2. Write a program which determines how many times a toss of 100 coins contains 47 heads if the experiment is performed 50 times. Your output should have the following form.
IN 50 EXPERIMENTS
THERE WERE 7 OCCURRENCES
OF 47 HEADS OUT OF 100
3. A gambler has a choice of two games. The first costs \$8.00 to play. Two dice are rolled and the player receive the sum of the numbers rolled in dollars. The second game costs \$15.00 to play. Two dice are rolled and the player receives the product of the numbers rolled in dollars. Write a program which simulates each game being played 1000 times and calculates the average winnings per game. Also determine which game the gambler should choose.