Indian Institute of Technology Bombay

Department of Electrical Engineering

Handout 24 EE 706 Communication Networks

Solutions to Assignment 3 March 26, 2010

1. **Ans.**

```
clear all;
numberOfRuns = 10;
p = 0.2; // Biased coin with probability of Heads equal to 0.2
for i=1:numberOfRuns
  if rand()< p
    printf("Heads\n");
  else
    printf("Tails\n");
  end
end
```

2. **Ans.**

```
clear all;
numberOfRuns = 100;
trueValueOfp = 0.75;
instances = bool2s([(rand(1,numberOfRuns)<trueValueOfp)]);
estimateOfp = sum(instances)/numberOfRuns;
```

The equality in the law of large numbers holds only when the number of instances is infinite. Since we are using a finite number of instances, the estimate and the true value are different. We can improve the estimate by increasing the number of instances, i.e. increase the value of the variable `numberOfRuns`.

3. **Stop-and-wait ARQ simulation:** There are many solutions possible

Solution 1:

```
clear all;
numberOfRuns = 100;
probFrameError = 0.1; // Probability of frame error
probAckError = 0.1;   // Probability of ACK error
roundTripTime = 3;    // Round trip time
timeoutDuration = 5;  // Duration of timeout
sampleSum = 0;
for i=1:numberOfRuns
  timeTaken = 0;
  while(rand()<probFrameError | rand()<probAckError)
```

```
    timeTaken = timeTaken+timeoutDuration;
  end
  timeTaken = timeTaken+roundTripTime;
  sampleSum = sampleSum+timeTaken;
end
avgTimeTaken = sampleSum/numberOfRuns
theoreticalAvgTime = roundTripTime + timeoutDuration*(probFrameError +
(1-probFrameError)*probAckError)/((1-probFrameError)*(1-probAckError))
```

Solution 2:

```
clear all;
numberOfRuns = 100;
probFrameError = 0.1; // Probability of frame error
probAckError = 0.1;   // Probability of ACK error
roundTripTime = 3;    // Round trip time
timeoutDuration = 5;  // Duration of timeout
sampleSum = 0;
for i=1:numberOfRuns
  timeTaken = 0;
  while(1)
    errorOccurrence = 0;
    if(rand()<probFrameError)
      errorOccurrence  = 1;
    elseif(rand()<probAckError)
      errorOccurrence = 1;
    end
    if(errorOccurrence == 0)
      break;
    end
    timeTaken = timeTaken+timeoutDuration;
  end
  timeTaken = timeTaken+roundTripTime;
  sampleSum = sampleSum+timeTaken;
end
avgTimeTaken = sampleSum/numberOfRuns
theoreticalAvgTime = roundTripTime + timeoutDuration*(probFrameError +
(1-probFrameError)*probAckError)/((1-probFrameError)*(1-probAckError))
```

The equality in the law of large numbers holds only when the number of instances is infinite. Since we are using a finite number of instances, the estimate and the true value are different. We can improve the estimate by increasing the number of instances, i.e. increase the value of the variable numberOfRuns.