Statistical Pattern Recognition
Assignment 1

Ali Gholami

Department of Computer Engineering & Information Technology
Amirkabir University of Technology

http://ceit.aut.ac.ir/~aligholamee
aligholamee@aut.ac.ir

Abstract

This is an introductory assignment to the world of *Statistics* and *Probability* in the world of *Pattern Recognition*. We'll introduce some key concepts like *Probability Distribution Function, Cumulative Distribution Function, Probability Density Function, Probability Mass Function, Joint Probability Density Function, Joint Cumulative Density Function, Marginal Density* & more details as the probabilistic point of view. Furthermore, we'll review the concepts of *Expected Value, Variance, Standard Deviation, Covariance & Correlation of Random Variables(e.g. Random Vectors), Univariate & Multivariate Gaussian Distribution, Total Probability & Bayes Theorem, Geometric & Mahalanobis Distances, Central Limit Theorem, Independence & Correlation* as the statistics point of view. Also, a principal concept called *Linear Transformation* is discussed. The relationship between these fields is far more important than each separately.

Key Words. *PDF, PMF, JPDF, JPMF, CDF, JCDF, Covariance Matrix, Correlation Coefficient, Correlation, Variance, Expected Vector, Gaussian Distribution, Marginal Probability, Linear Tranformation, Eigenvector, Eigenvalue, Rank.*

1. Expectation Properties

A random variable X has $E(X) = -4$ and $E(X^2) = 30$. Let $Y = -3X + 7$. Compute the following.

(a) $V(X)$

(b) $V(Y)$

(c) $E((X + 5)^2)$

(d) $E(Y^2)$

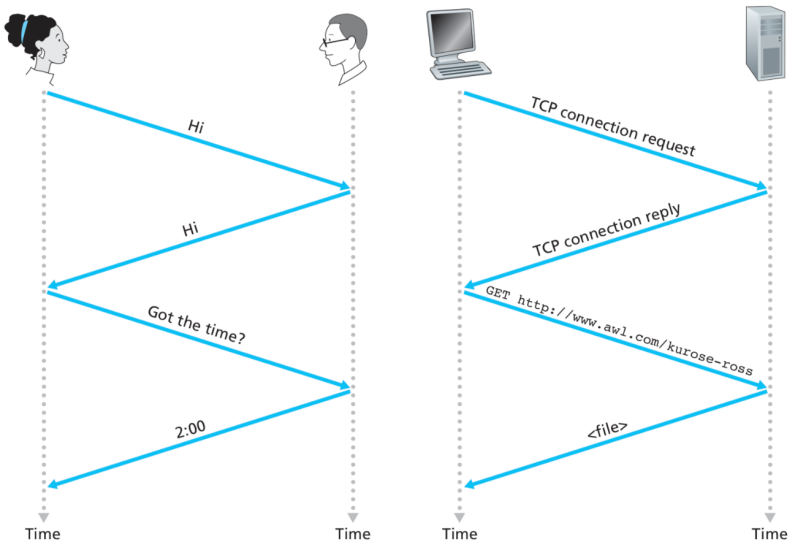

Figure 0.1: TCP connection request sample

Solution

Assuming the data is transferred via *packets*, a label has to be given to each packet of data. These labels are called *headers*. The objective of these headers is to provide some information about each of these packets of data. These information include *source and destination nodes address, class of message(including the objective codes, message origin, class functions).* In addition to that, the main *data elements* are present in each packet. We'll propose a high-level abstraction of protocol classes below. Each of these classes specifies the overall purpose of the message.

1. Authorization Message
    - Authorize the card pass phrase
    - Determine if funds are available
    - Determine if the destination card exists in a card-to-card transaction
2. Financial Message
    - Post funds to the accounts in card-to-card transactions
    - Post funds to the accounts in *POS* transactions
    - Fund posting approvals
3. Reversal & Rollback Message

Message	*Action*	*Device*
Authorization	Request for authorization	ATM
Authorization	Repeat authorization request	ATM
Authorization	Respond to authorization request	Central Computer
Financial	Request for fund	ATM
Financial	Repeat fund request	ATM
Financial	Respond to financial request	Central Computer
Financial	Request for account report	ATM
Financial	Respond to account report	Central Computer
Reversal	Reverse a card-to-card transaction	ATM
Reversal	Rollback a card-to-card transaction	ATM
Administrative	Request for public announcement due date	ATM
Administrative	Respond to the public announcement	Central Computer
Network Management	Echo test	ATM
Network Management	Respond to Echo test	Central Computer

Table 0.1: Demonstration of proposed *ATM* network protocol classes.

- Reverse the previous authorization action
- Rollback the previous financial message

4. Administrative Message
    - Transmit the administrative messages and advices
    - Public announcements on the *ATM*
5. Network Management Message
    - Secure key exchange

A complete example of a fund request is described in the figure 1.2. **Firstly**, the *ATM* sends an authorization request to the central computer. **Secondly**, The central computer responds to the incoming request. **Thirdly**, in case the authorization is successful, a fund request is sent to the central computer. **Fourthly**, the fund request is validated and the reponse is sent to the *ATM*. In the situation, the user might ask for a reversal. If that happens, the reversal requests/responses are transferred.

Please refer to the beginning of this solution for the assumptions about the *transport* layer.

2. HFC & Collision in Downstream

Given an *HFC* communication medium, find out whether the transmission rate is *dedicated* to one user or it is shared among users in the network. Is it possible for a downstream in an *HFC* channel to have collision? Describe your answer.

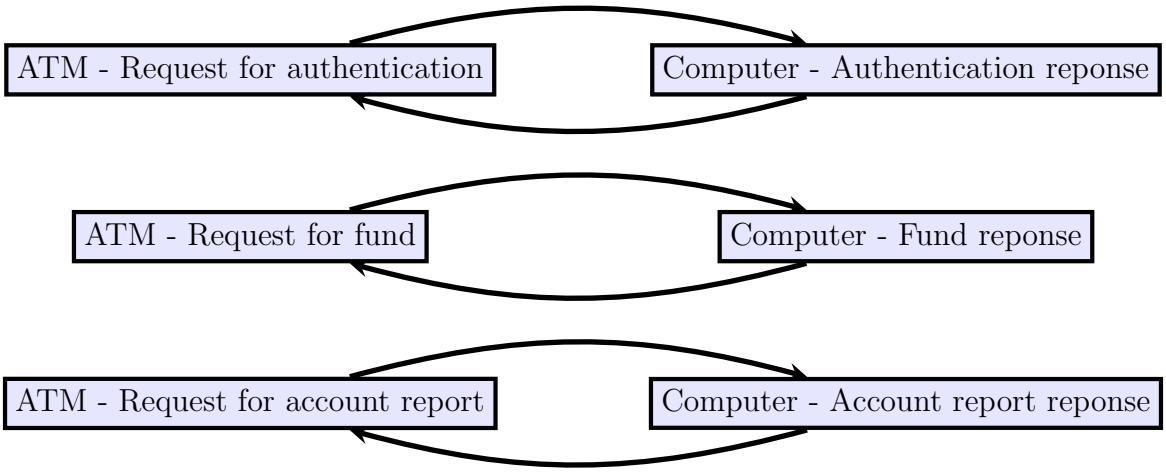

Figure 0.2: A complete fund request flow diagram.

Solution

As the description for the *HFC(Hybrid fiber-coaxial)* medium specifies, the combination of both *optical fiber* and *coaxial cable* is used in a broadband network. As an example for the functionality of this medium, the television channels are sent from the cable system's distribution facility, the ***headend***, to local communities through optical fiber subscriber lines. At the local community, a box called an *optical node* translates the signal from a light beam to electrical signal, and sends it over coaxial cable lines for distribution to subscriber residences.

HFC Transmission Rate HFC bandwidth is shared among users. So, each user on a tail-end of the coaxial cable can use the same transmission rate as others.

Collision in Downstream The downstream channel, provides the data from a single source called head-end. Then the data is distributed among the residences. Thus, there are no collisions in the downstream channel.

3. Dial-up, ADSL, FTTH, HFC Modems

The modems titled here are widely used as a home-access to the Internet. Provide an example of *maximum transmission rate*. Describe whether these rates are shared or not.

Solution

Table 1.2 provides various *transmission rates(Bitrate)* for each of these modems.

Modem	*Bitrate*	*Usage*
Dial-up	33.6(kbit/s) – 48(kbit/s) – 56(kbit/s)	Unshared
ADSL	8.0(Mbit/s) – 12.0(Mbit/s) – 24(Mbit/s)	Unshared – Shared
HFC	100(Mbit/s)	Shared
FTTH	1(Gbit/s)(Google Fiber)	Unshared(one single home)

Table 0.2: Bitrate samples for different types of modems.