Formal Language and Automata Theory Syllabus

Module I: Introduction to Automata

- Mathematical model of digital devices (including real computers)
- State Transition Graph
- Finite Automaton (FA) and its types
  - Deterministic Finite Automaton (DFA)
  - Non-deterministic Finite Automaton (NDFA)
- Operations on FA:
  - Complement
  - Union
  - Intersection
- Conversion Strategy from NDFA to DFA
- Minimization of FA
- Finite Automaton with Output
- Applications of FA

Duration: 15 Lectures

Module II: Regular Expressions (RE)

- Introduction to Regular Expressions
- R.E.'s and basic operations
- Algebraic laws on Regular Expression
- Finite and Infinite Languages
- Equivalence of finite Automaton and regular expressions
- Constructing NDFA from Regular Expression
- Pumping Lemma for Regular Language
- Closure properties of Regular Languages
- Non-regular languages
- Applications of Regular Expression

Duration: Lectures

Module III: Grammar

- Introduction and Formal Definition of Grammar
- The Chomsky Hierarchy of Grammar
- Designing Regular grammar from DFA
- Context Free Grammar (CFG)
- Closure properties of Context Free Languages
- CFG and Normal forms:
  - Chomsky Normal Form
  - Greibach Normal Form
- Non-Context Free Language
- Applications of CFGs

Duration: Lectures

Module IV: Push Down Automaton (PDA)

- Introduction and Definition of PDA
- Types of Pushdown Automata:
  - Deterministic PDA (DPDA)
  - Non-deterministic PDA (NPDA)
- Converting CFG to PDA
- Derivation (Parsing)
- Parsing Techniques
- Ambiguous and Unambiguous Grammar
- Demerits of Ambiguous Grammar

Duration: Lectures

Module V: Turing Machine (TM)

- Single Tape TM
- Variations of TM
- Halting Problem
- Turing Machine and Languages
- Enumerable Languages
- Decidable, Recognizable, and Undecidable languages
- Solvable and Unsolvable problems
- Post Correspondence Problems (PCP)
- Classes of Problems:
  - P
  - NP
  - NP-C

- NP-Hard

Duration: Lectures

Text Book

[T[6]] Hopcroft J.E., Motwani R. and Ullman J.D, "Introduction to Automata Theory, Languages and Computations", Second Edition, Pearson Education, [2013] .

Reference Books

[6] . [R[6]] Mishra K.L.P. and Chandrasekaran N., "Theory of Computer Science: Automata, Languages and Computation", [8] rd Edition, PHI.
[7] . [R[7]] Martin John C., "Introduction to Languages and the Theory of Computation", [8] rd Edition, Tata McGraw Hill Publishing Company, [Uluberia] , [2012] .
[8] . [R[8]] Lewis Harry R. and Papadimitriou Christos H., "Elements of the theory of Computation", [7] nd Edition, Prentice-Hall of India Pvt. Ltd.

Data Mining Syllabus

Module I: Introduction to Data Mining and Data Processing

Data Mining:

- Introduction
- Relational Databases
- Data Warehouses
- Transactional databases
- Advanced database Systems and Application
- Data Mining Functionalities
- Classification of Data Mining Systems
- Major Issues in Data Mining

Data Processing:

- Data Cleaning
- Data Integration and Transformation
- Data Reduction
- Data Discretization and Concept Hierarchy Generation

Duration: Lectures

Module II: Data Warehouse

- Introduction
- A Multidimensional data Model
- Data Warehouse Architecture
- Data Warehouse Implementation
- Data Cube Technology
- From Data Warehousing to Data Mining
- Data Cube Computation and Data Generalization

Duration: Lectures

Module III: Mining Association Rules in Large Databases

- Association Rule Mining
- Single-Dimensional Boolean Association Rules
- Multilevel Association Rules from Transaction Databases
- Multi Dimensional Association Rules from Relational Databases
- From Association Mining to Correlation Analysis
- Constraint-Based Association Mining

Duration: [15] Lectures

Module IV: Classification and Prediction

- Classification & Prediction
- Issues Regarding Classification & Prediction
- Classification by decision Tree Induction
- Bayesian Classification
- Classification by Back propagation
- Classification based on concepts & Association Rule Analysis
- Other Classification Methods
- Prediction
- Classification Accuracy

Duration: Lectures

Module V: Cluster Analysis

- Introduction
- Types of Data in Cluster Analysis
- A Categorization of Major Clustering Methods
- Partitioning Method:
  - k-Medoids Algorithm
  - CLARANS
- Hierarchical Methods:
  - BIRCH
  - ROCK
- Density-Based Methods:
  - DBSCAN
- Grid-Based Methods:
  - STING
  - WaveCluster
- Outlier Analysis

Duration: Lectures

Text Book

[T[6] | Han Jiawei & Kamber Micheline, "Data Mining Concepts & Techniques", [7] nd Edition, Publisher Harcout India Private Limited.

Reference Books

[6] . [R[6] | Gupta G.K., "Introduction to Data Mining with case Studies", PHI, Uluberia , 2011 .
[7] . [R[7] | Berson A. & Smith S. J., "Data Warehousing Data Mining", COLAP, TMH, Uluberia , 2009 [9] .
[8] . [R[8] | Dunham H.M. & Sridhar S., "Data Mining", Pearson Education, Uluberia , 2011 .

Data Communication and Computer Networks Syllabus

Module I: Data Communications and Networking Overview

- A Communications Model
- Data Communications
- Data Communication Networking
- The Need for Protocol Architecture
- A Simple Protocol Architecture
- OSI
- The TCP/IP Protocol Architecture
- Data Transmission Concepts and Terminology
- Analog and Digital Data Transmission
- Transmission Impairments
- Channel Capacity

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Module II: Transmission Media and Signal Encoding Techniques

- Guided Transmission Media
- Wireless Transmission
- Wireless Propagation
- Line-of-Sight Transmission
- Digital Data Digital Signals
- Digital Data Analog Signals
- Analog Data Digital Signals
- Analog Data Analog Signals

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Module III: Digital Data Communication Techniques and Data Link Control

- Asynchronous and Synchronous Transmission
- Types of Errors
- Error Detection
- Error Correction
- Line Configurations
- Interfacing
- Flow Control
- Error Control
- High-Level Data Link Control (HDLC)

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Module IV: Multiplexing, Circuit Switching, and Packet Switching

- Multiplexing
  - Frequency Division Multiplexing
  - Synchronous Time Division Multiplexing
  - Statistical Time Division Multiplexing
- Switching Networks
  - Circuit-Switching Networks
  - Circuit-Switching Concepts
  - Control Signaling
  - Soft switch Architecture
  - Packet-Switching Principles
  - X.3
  - Frame Relay

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Module V: Asynchronous Transfer Model and Routing in Switched Networks

- Protocol Architecture
- ATM Logical Connections
- ATM Cells
- Transmission of ATM Cells
- ATM Service Categories
- ATM Adaptation Layer
- Routing in Switched Networks
  - Routing in Circuit-Switching Networks
  - Routing in Packet-Switching Networks
  - Least-Cost Algorithms

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Text Book

Stallings W., Data and Computer Communications, 15 **th Edn., Pearson Education, PHI,** Uluberia , 2019 9 . **(T**6 **)**

Reference Book

Forouzan B. A., Data Communications and Networking, th Edn., TMH, Uluberia , 2022 . **(R**6 **)**

Information Retrieval

Syllabus

Module I: Introduction

- **Topics Covered**:
  - Introduction to Search Engines
  - Search Engine Architecture
  - Overview of Key Concepts:
    - Crawling
    - Text Transformation
    - Index Creation
    - User Interaction
    - Ranking
    - Link Analysis
    - Evaluation
    - Deep Web
- **Lecture Hours**:

Module II: Pre-processing and Indexing

- **Pre-processing**:
  - Tokenization
  - Stop Words
  - Normalization
  - Stemming
  - Wildcard Queries
  - Spelling Correction Techniques:
    - Edit Distance
    - K-gram
- **Indexing**:
  - Index Construction
  - Index Compression
- **Lecture Hours**: 6 7 L

Module III: Scoring

- **Topics Covered**:
  - Parametric and Zone Indexes
  - Term Frequency and Weighting
  - Vector Space Model
  - Efficient Scoring and Ranking
  - Vector Space Scoring
- **Lecture Hours**:

Module IV: Information Retrieval (IR) Evaluation

- **Topics Covered**:
  - Evaluation Methods
  - Standard Test Collections
  - Evaluation of Unranked and Ranked Retrieval Systems
  - Assessing Relevance
  - System Quality vs. User Utility
- **Lecture Hours**: L

Module V: Relevance Feedback and Query Expansion

- **Topics Covered**:
  - Relevance Feedback
  - Pseudo Relevance Feedback
  - Query Reformulation Techniques
- **Lecture Hours**: L

Textbook

- **Manning, Christopher D., Raghavan Prabhakar, and Schütze Hinrich**.
  Introduction to Information Retrieval. Kalyan-Dombivli : Kalyan-Dombivli University Press, 2013 . (T[6])

Reference Books

[6] . **Grossman David A., Frieder Ophir**.
Information Retrieval: Algorithms and Heuristics. Springer. (R[6])

[7] . **Croft Bruce, Metzler Donald, and Strohman Trevor**.
Search Engines: Information Retrieval in Practice. Pearson Education, 2014 . (R[7])

[8] . **Ricardo Baeza-Yates and Neto Berthier Ribeiro**.
Modern Information Retrieval, [7] nd Edition, Addison-Wesley, 2016 . (R[8])

Basic IT Workshop

Module I: Introduction to MATLAB and Basics Part I

- Introduction, Advantage, Disadvantage of MATLAB
- MATLAB Environment
- Variables and Array
- Built-in Functions of MATLAB
- Subarrays
- Multidimensional Arrays
- Data Files

Module II: MATLAB Basics Part II

- Scalar and Array Operations
- Hierarchy of Operations
- Introduction to Plotting
- Polar Plots
- Subplots
- MATLAB Profiler

- String Functions
- Complex Data
- Three-Dimensional Plot

Module III: MATLAB Advanced Features

- Sparse Arrays
- Cell Arrays
- Structure Arrays
- I/O Functions
- Object Handles
- Position and Units
- Graphical User Interface: Dialog Boxes, Menus, Toolbars

Module IV: Introduction to Python Basics

- Basics
- IPython
- Data Types
- Operators
- Arrays
- Plotting

Module V: Python Programming Part II

- Functions and Loops
- Object-Oriented Programming
- Numerical Formalism

Sample List of Assignments

Sample Assignments on Python

Data Types, Input-Outputs, Variables

6. Write a program in Python to swap two variables.
7. Write a program in Python to check if the input character is an alphabet or not.

Loop

8. Write a program in Python to shuffle a deck of cards using the `random` module and draw cards.
9. Write a program in Python to find the factors of a number.

Array and Lists

. Write a program in Python to transpose a given matrix `M = [[6, 7], [9,  ], [8,  ]]` .