University of Gour Banga

(Established under West Bengal Act XXVI of 2007)

N.H.-34(Near Rabindra Bhawan), P.O.:Mokdumpur Dist.: Malda,
West Bengal, Pin-732103

M.Sc. in Computer Science

Two Years (Four Semesters) Syllabus

Main Feature of the Syllabus

M.Sc. in Computer Science

Semester	Paper Code	Paper Name	Nature	Periods/ Week	Exam Marks	Time	Sessional	Total Marks
I	Paper I	Design and Analysis of Algorithms	Theo.	3	40	2.00 Hr.	10	50
	Paper II	Advanced DBMS	Theo.	3	40	2.00 Hr.	10	50
	Paper III	Advanced Computer Architecture and Microprocessors	Theo.	3	40	2.00 Hr.	10	50
	Paper IV	Advanced Software Engineering	Theo.	3	40	2.00 Hr.	10	50
	Paper V	Digital Logic and Microprocessors Lab	Lab-I	6	40	3.00 Hr.	10	50
Total					**200**		**50**	**250**
II	Paper VI	Object Oriented Programming with JAVA	Theo.	3	40	2.00 Hr.	10	50
	Paper VII	Compiler Design	Theo.	3	40	2.00 Hr.	10	50
	Paper VIII	Artificial Intelligence	Theo.	3	40	2.00 Hr.	10	50
	Paper IX	Computer Networks and Wireless Communications	Theo.	3	40	2.00 Hr.	10	50
	Paper X	Object Oriented Programming with JAVA Lab	Lab-II	6	40	3.00 Hr.	10	50
Total					**200**		**50**	**250**
III	Paper XI	Advanced Operating Systems	Theo.	3	40	2.00 Hr.	10	50
	Paper XII	Pattern Recognition and Image Processing	Theo.	3	40	2.00 Hr.	10	50
	Paper XIII	Advanced Operating Systems Lab	Lab-III	6	40	3.00 Hr.	10	50
	Paper XIV	Pattern Recognition and Image Processing Lab	Lab-IV	6	40	3.00 Hr.	10	50
	Paper XV	Project-I	Project		40	3.00 Hr.	10	50
Total					**200**		**50**	**250**
IV	Paper XVI	Elective-I	Theo.	3	40	2.00 Hr.	10	50
	Paper XVII	Elective-II	Theo.	3	40	2.00 Hr.	10	50
	Paper XVIII	Project –II	Project		40	3.00 Hr.	10	50
	Paper XIX	Seminar			40	2.00 Hr.	10	50
	Paper XX	Grand Viva-voce			40	2.00 Hr.	10	50
Total					**200**		**50**	**250**
Grand Total					**800**		**200**	**1000**

List of Elective Papers

1. **Parallel Computing**
2. **Image Processing**
3. **Mobile Computing**
4. **Modeling and simulation**
5. **Natural Language Processing**
6. **Data Mining and Data Warehousing**
7. **Cryptography**
8. **Embedded Systems**
9. **Bio-Informatics**
10. **Machine Learning**
11. **Information Security**
12. **Multimedia Technology**
13. **Social Network Analysis**
14. **Game Theory**
15. **Bigdata Analytics**
16. **Human Computer Interaction**
17. **Computational Intelligence:**
18. **Quantum Computation**

Detailed Syllabus

Paper I: Design and Analysis of Algorithms

Review of basic algorithmic analysis: Asymptotic analysis of upper and average complexity bounds; best, average, and worst case behaviors; big-Oh, big-Omega and big-Theta; standard complexity classes; empirical measurements of performance; time and space tradeoffs in algorithms; recurrence relations

Divide and Conquer: Merge Sort**.** Quick Sort, Selection Problem, Median and Order Statistics, Strassen's Matrix Multiplication, Convex Hull Algorithms.

Greedy Algorithm: Knapsack algorithm, Huffman Codes, Task Scheduling

Dynamic Programming: Chained matrix multiplication

Backtracking Algorithms: 8 queens problem

Branch and Bound: Travelling Salesman problem.

Graph and Tree Algorithms : BFS, DFS, Topological Sort, Minimum Spanning Tree(Prim's and Kruskal's Algorithm), Dijkstra's Algorithm, Bellman Ford Algorithm, Bipartite Graphs, Binary Search Tree, AVL tree, 2-3 Tree, Red Black Tree, Splay Tree – Amortized analysis.

Complexity Theory: Tractable and intractable problems, Concepts of computable functions; Polynomial reducibility: P and NP- Definition of the classes P and NP, NP-completeness (Cook's theorem), Standard NP complete problems.

Books and References:

1. T.H. Cormen, C.E.Leiserson, R.L. Rivest, and C. Stein, Introduction to Algorithms, McGraw-Hill, 2002.
2. Sara Baase, Computer Algorithms: Introduction to Design and Analysis, Addison Wesley, 1999.
3. R. Motwani and P. Raghavan, Randomized Algorithms, Cambridge University Press, 1995.
4. Teofilo F. Gonzalez, Handbook of NP-Completeness: Theory and Applications Chapman & Hall, 2009.
5. Vijay V. Vazirani, Approximation Algorithms, Springer-Verlag, France, 2006.
6. S. Rajasekharan and John Reif, Handbook of Parallel Computing: Models, algorithms and applications, Chapman and Hall/CRC, 2007.
7. Gareth A. Jones and Josephine M. Jones, Elementary Number Theory, Springer, 1998.
8. F P Preparata and M I Shamos, Computational Geometry: An Introduction Springer, 1993.

Paper II: Advanced DBMS

Relational Database Management Issues: Transaction Processing, Concurrency, Recovery, Security and Integrity.

Distributed Databases: Storage structures for distributed data, data fragmentation, Transparency of distributed architecture, Distributed query processing, Transaction management in distributed environment, Recovery and Concurrency control, Locking protocols, Deadlock handling, Dynamic modeling of distributed databases, Client - Server Databases. Performance Tuning, Advanced Transaction Processing.

Object-oriented Databases: Objects and Types, Specifying the behavior of objects, Implementing Relationships, Inheritance. Sample Systems. New Database Applications.

Multimedia Database: Multimedia and Object Oriented Databases, Basic features of Multimedia data management, Data Compression Techniques, Integrating conventional DBMSs with IR and Hierarchical Storage Systems, Graph Oriented Data Model, Management of Hypertext Data, Client Server Architectures for Multimedia Databases

Books and References:

1. H. F. Korth& A. Silverschatz: Database Systems Concepts, McGraw Hill.
2. Bindu R. Rao: Object Oriented Databases, McGraw Hill, 1994.
3. Gray, Kulkarni, Paton: Object Oriented Databases, Prentice Hall International, 1992.
4. Khoshafian: Object Oriented Databases, John Wiley & Sons, 1993.
5. S. Khoshafian& A.B. Baker, Multimedia and Imaging Databases, Morgan Kaufmann Publishers, 1996.
6. Kemper & Moerkoette: Object-Oriented Database Management, PH, 1994.
7. Alex Berson: Client/Server Architecture, McGraw Hill.

Paper III Advanced Computer Architecture and Microprocessors

Group-A: Advanced Computer Architecture:

Review of Pipelining, Examples of some pipeline in modern processors, pipeline hazards, data hazards, control hazards. Techniques to handle hazards, performance improvement with pipelines and effect of hazards on the performance.

Vector processors- Use and effectiveness, memory to memory vector architectures, vector register architecture, vector length and stride issues, compiler effectiveness in vector processors.

SISD, MISD, MIMD, Single instruction multiple data stream (SIMD) architectures. Array processors, comparison with vector processors, example of array processors such as MMX Technology.

RISC architectures, addressing modes, instructions formats, effect of simplification on the performance, example processors such as MIPS, PA-RISC, SPARC, Power PC, etc.

MIMID Multiprocessors, Centralized shared architectures, distributed shared memory architectures, synchronization and memory consistency models, message passing architectures, comelier issues. Data flow architectures, Interconnection networks.

Books and References:

1. M Morris Mano: Computer System Architecture
2. Carter: Computer Architecture (Schaum Series),TMH
3. Patterson D.A. and Hennessy , J.L. : “Computer architecture a quantitative approach”, 2nded., Morgan Kaufman, 1996

Group B: Microprocessors

Internal architecture of a microprocessor, registers – general purpose, special purpose, accessible to the user, inaccessible to the user.

Stack organization – register stack, Stack operations, A register stack with overflow and underflow to memory, memory stack. Instruction formats, 0, 1, 2-address instructions, addressing modes, categories of instructions according to functions – data movement, arithmetic and logic, program control, I/O, stack.

Intel 8085/8086 microprocessors, functional block description, pin description, operating modes – minimum and maximum modes, register organization, bus organization, clock generators, interrupts, memory and I/O read-write cycles, timing diagrams, addressing modes, instruction sets and programming.

Data transfer schemes – programmed transfer: synchronous, asynchronous, interrupt driven, multiple interrupts, device polling. DMA controller, cycle stealing and block modes, Serial transfer.

Peripherals: 8279, 8255, 8251, 8253, 8237, 8259, A/D and D/A converters and interfacing of the same.

Typical applications of a microprocessor.

Brief overview of some other microprocessors (eg. Pentium).

Books and References:

1. Ramesh S. Gaonkar: Microprocessor architecture, programming and applications with 8085/8085A, Wiley eastern Ltd, 1989.
2. Intel Corp: The 8085 / 8085A. Microprocessor Book – Intel marketing communication, Wiley inter science publications, 1980.
3. Adam Osborne and J. Kane: An introduction to micro-computers Vol. 2 – some real Microprocessor – Galgotia Book Source, New Delhi
4. Intel Corp. Micro Controller Handbook – Intel Publications, 1994.
5. Douglas V. Hall: Microprocessors and Interfacing, McGraw Hill International Ed. 1992
6. Alan R. Miller: Assembly Language Programming the IBM PC, SubexInc, 1987
7. Bary B. Brey: The Intel Microprocessors: 8086/8088, 80186, 80286, 80386 & 80486, Prentice Hall, India 1996.

Paper IV: Advanced Software Engineering

Review of Software Engineering Fundamentals

System Requirement Specification: DFD, Data Dictionary, ER diagram, Process Organization & Interactions.

System Design: Problem Partitioning, Top-Down and Bottom-Up design; Decision tree, decision table and structured English; Functional vs. Object- Oriented approach.

Coding & Documentation: Structured Programming, OO Programming, Information Hiding, Reuse, System Documentation.

Testing: Levels of Testing, Integration Testing, Test case Specification, Reliability Assessment, Validation & Verification Metrics, and Monitoring & Control.

Software Project Management: Project Scheduling, Staffing, Software Configuration Management, Quality Assurance, Project Monitoring.

CASE TOOLS: Concepts, use and application.

Books and References:

1. R. G. Pressman: Software Engineering, TMH
2. Behforooz: Software Engineering Fundamentals, OUP
3. Ghezzi: Software Engineering, PHI
4. Sommerville, Ian: Software Engineering, Pearson Education

Paper V: Digital Logic and Microprocessor (Practical Paper)

Digital Logic (Using Bread Board**):** Design of different combinational and sequential digital circuits with at least one digital IC.

Microprocessors: Using 8085/8086 microprocessor kits, interfacing with PC, writing and executing assembly language programs using PC, conversion to hex code, downloading to kit, executing programs in the kit from the PC, uploading programs from kit to PC, disassembling.

Paper VI: Object Oriented Programming with JAVA

Java Fundamentals: Features of Java, OOPs concepts, Java virtual machine, Reflection byte codes, Byte code interpretation, Data types, variable, arrays, expressions, operators, and control structures, Objects and classes

Java Classes: Abstract classes, Static classes, Inner classes, Packages, Wrapper classes, Interfaces, This, Super, Access control

Exception handling: Exception as objects, Exception hierarchy, Try-catch, finally, Throw, Throws

IO package: Input streams, Output streams, Object serialization, Deserialization, Sample programs on IO files, Filter and pipe streams

Multi threading: Thread Life cycle, Multi threading advantages and issues, Simple thread program, Thread synchronization

GUI: Introduction to AWT programming, Layout and component managers, Event handling, Applet class, Applet life-cycle, Passing parameters embedding in HTML, Swing components – JApplet, JButton, JFrame, etc. Sample swing programs

Database Connectivity: JDBC architecture, Establishing connectivity and working with connection interface, Working with statements, Creating and executing SQL statements, Working with Result Set

Books and References:

1. Bruce Eckel: Thinking in Java 3rd Edition, Prentice Hall
2. Herbert Schildt: Java: The Complete Reference, 9th Edition, Tata Mcgraw Hill Education Private Limited
3. Deitel and Dietel: Java How to Program 9th Edition, PHI Learning
4. Cay S. Horstmann: Core Java, Volume I : Fundamentals (English) 9th Edition, Pearson India
5. Bert Bates, Kathy Sierra: SCJP Sun Certified Programmer for Java 6, Tata Mcgraw Hill Education Private Limited

Paper VII: Compiler Design

Introduction to Compiling: Compilers, Analysis of the source program, The phases of the compiler, Cousins of the compiler.

Lexical Analysis: The role of the lexical analyzer**,** Tokens, Patterns, Lexemes, Input buffering, Specifications of a token, Recognition of a tokens, Finite automata, From a regular expression to DFA, Design of a lexical analyzer generator (Lex).

Syntax Analysis : The role of a parser, Context free grammars, Writing a grammar, Top down Parsing, Non-recursive Predictive parsing (LL), Bottom up parsing, Handles, Viable prefixes, Operator precedence parsing, LR parsers (SLR, LALR)

Syntax directed translation: Syntax director definitions, Construction of syntax trees, Bottom-up evaluation of S attributed definitions, L attributed definitions, Bottom-up evaluation of inherited attributes.

Type checking: Type systems, Specification of a simple type checker, Equivalence of type expressions, Type conversions

Code optimization: Introduction, Basic blocks & flow graphs, Transformation of basic blocks, Dag representation of basic b locks, The principle sources of optimization, Loops in flow graph, Peephole optimization.

Code generations: Issues in the design of code generator, a simple code generator, Register allocation & assignment.

Books and References:

1. Aho, Sethi, Ullman: Compiler Principles, Techniques and Tools, Pearson Education.
2. Kain: Theory of Automata & Formal Language, McGraw Hill.

Paper VIII: Artificial Intelligence:

Introduction:

Introduction to AI applications and AI techniques, Production systems, control strategies, reasoning - forward and backward chaining.

Intelligent Agents: Definitions of a rational agent, reflex, model-based, goal-based, and utility-based agents, the environment in which a particular agent operates.

Searching Techniques and Game Playing: Breadth first search, depth first search, iterative deepening, uniform cost search, hill climbing, simulated annealing, genetic algorithm search, heuristic search, Best first search, A* algorithm, IDA* algorithm, AND/OR Tree, AO* algorithm, Minmax and game trees, refining minmax, Alpha – Beta pruning, constraint satisfaction.

Knowledge Representation: Propositional logic, First order predicate calculus, resolution, unification, natural deduction system, refutation, logic programming, PROLOG, semantic networks, frame system, value inheritance, conceptual dependency, Ontologies.

Planning: basic representation for planning, symbolic-centralized vs. reactive-distributed, partial order planning algorithm.

Uncertainty: different types of uncertainty - degree of belief and degree of truth, various probability constructs - prior probability, conditional probability, probability axioms, probability distributions, and joint probability distributions, Bayes' rule, other approaches to modeling uncertainty such as Dempster-Shafer theory and fuzzy sets/logic.

Books and References:

1. S. Russell and P. Norvig: Artificial Intelligence: A Modern Approach (2nd ed.), Pearson Education, 2006.
2. Elaine Rich and Kelvin Knight: Artificial Intelligence, Tata McGraw Hill, 2002.
3. Nils J Nilson, Artificial Intelligence: A New Synthesis, Morgan Kaufmann Publishers,Inc., San Francisco, California, 2000.
4. R. Akerkar: Introduction to Artificial Intelligence, Prentice-Hall of India, 2005
5. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems:PrenticeHall of India, 2006.
6. Nils J. Nilson: Principles of Artificial Intelligence, Narosa Publishing House, 2001
7. W.F. Clocksin and C.S. Mellish: Programming in PROLOG, Narosa Publishing House,2002.
8. Saroj Kaushik: Logic and Prolog Programming, New Age International Publisher,2006.

Paper IX: Computer Networks and Wireless Communications

Overview of data communication and Networking: Introduction; Data communications: components, direction of data flow (simplex, half duplex, full duplex); Networks: distributed processing, network criteria, physical structure (type of connection, topology), categories of network (LAN, MAN, WAN); OSI reference model, TCP/IP reference model, their comparative study.

Physical level: Overview of data (analog & digital), transmission (analog & digital) & transmission media (guided & non-guided); TDM, FDM, Circuit switching: time division & space division switch,

Data link layer: Types of errors, framing (character and bit stuffing), error detection & correction methods; Flow control; Protocols: Stop & wait ARQ, Go-Back- N ARQ, Selective repeat ARQ, HDLC;

Medium access sub layer: Point to point protocol, LCP, NCP, FDDI, token bus, token ring; Reservation, polling, concentration; Multiple access protocols: Pure ALOHA, Slotted ALOHA, CSMA, CSMA/CD, Traditional Ethernet, fast Ethernet;

Network layer: Internetworking & devices - Repeaters, Hubs, Bridges, Switches, Router, Gateway; Addressing : Internet address, classification, subnetting ; Routing : techniques, static vs. dynamic routing, Routing algorithms - shortest path algorithm, flooding, distance vector routing, link state routing; Protocols: ARP, RARP, IP, ICMP, IPV6; Unicast and multicast routing protocols.

Transport layer: Process to process delivery; UDP; TCP; Congestion control algorithm: Leaky bucket algorithm, Token bucket algorithm,

Application layer: DNS, SMTP, SNMP, FTP, HTTP & WWW; Network Security and Cryptography.

Modern topics: ISDN services & ATM; DSL technology, Cable modem, Sonet.

Wireless LAN: IEEE 802.11, Introduction to blue-tooth, VLAN's, Cellular & Satellite networks.

Books and References:

1. B. A. Forouzan: Data Communications and Networking (3rdEd.), TMH
2. A. S. Tanenbaum: Computer Networks (4thEd.), Pearson Education/PHI
3. W. Stallings: Data and Computer Communications (5thEd.), PHI/ Pearson Education

Paper X: Object Oriented Programming with JAVA Lab

1. Programs using constructor and destructor.
2. Creation of classes and use of different types of functions.
3. Count the number of objects created for a class using static member function.
4. Write programs on interfaces.
5. Write programs on packages.
6. Write programs using function overloading.
7. Programs using inheritance.
8. Programs using IO streams.
9. Programs using files.
10. Write programs using exception handling mechanism.
11. Programs using AWT
12. Programs on swing.
13. Programs using JDBC.

Paper XI: Advanced Operating Systems

Introduction to UNIX/Linux Kernel: System Structure, User Perspective, Assumptions about Hardware, Architecture of UNIX Operating Systems, Concepts of Linux Programming- Files and the File system, Processes, Users and Groups, Permissions, Signals, Inter process Communication

Process Environment, Process Control and Process Relationships: Process states and transitions, layout of system memory, the context of a process, saving the context of a process, sleep, process creation, signals, process termination, awaiting process termination, invoking other programs, the user id of a process, changing the size of the process, The Shell, Process Scheduling, Process termination, environment list, memory layout of a C program, shared libraries, environment variables, setjmp and longjmp, getrlimit and setrlimit, process identifiers, fork, vfork, exit, wait and waitpid, waitid, wait3 and wait4, race conditions, exec, changing user IDsand group IDs, system function, user identification, process times,The Process ID, Running a New Process, Terminating a Process, Waiting for Terminated ChildProcesses, Users and Groups, Daemons, Process Scheduling, Yielding the Processor, Process Priorities, Processor Affinity

Memory Management: The Process Address Space, Allocating Dynamic Memory, Managing Data Segment, Anonymous, Memory Mappings, Advanced Memory Allocation, Debugging Memory Allocations, Stack-Based, Allocations, Choosing a Memory Allocation Mechanism, Manipulating Memory, Locking, Memory, Opportunistic Allocation, Swapping, Demand Paging

Windows Thread Management: Thread Internals**,** Data Structures, Kernel Variables, Performance Counters, Relevant Functions, Birth of a Thread Examining Thread Activity, Limitations on Protected Process Threads, Worker Factories (Thread Pools)**,** Thread Scheduling**,** Overview of Windows Scheduling, Priority Levels, Windows Scheduling APIs, Relevant, Tools, Real-Time Priorities, Thread States, Dispatcher Database, Quantum, Scheduling Scenarios, Context Switching, Idle Thread, Priority Boosts

Books and References:

1. Robert Love: Linux System Programming, O'Reilly.
2. Mark E. Russinovich and David A. Soloman: Windows Internals, Microsoft Press.
3. Maurice J. Bach: The Design of the UNIX Operating System, PHI.
4. Richard Stevens: Advanced Programming in the UNIX Environment, Addison-Wesley,

Paper XII: Pattern Recognition and Machine Intelligence

Introduction to pattern recognition and learning: Supervised, Unsupervised, training and test sets, feature selection.

Mathematical Background: Measurements and features in regard to image processing. Revision of basic probability & statistics: joint probabilities, central limit theorem, Bayes' theorem, covariance, independence and correlation, Lagrange multipliers.

Feature Selection: Search algorithms, branch & bound, scatter matrices, criteria functions. Feature selection by global optimization: (meta)-heuristic methods: genetic algorithms, simulated annealing.

Feature Extraction: Linear feature extraction: PCA, LDA-Fisher mapping. Nonlinear feature extraction: overview, multidimensional scaling, dissimilarity-based classifiers & embedding

Supervised learning and classification:

Bayesian Classifiers: Bayes decision theory, Bayes classifier, Bayes error & risk, logistic classifier. Parzen classifier, k-NN classifier, proportional classifier.

Linear Regression: Bayesian regression. MMSE estimator, MAP estimator, ML estimator, Model evaluation, Quality of regression.

Nonlinear & Multidimensional Regression: Nonlinear regression, kernel smoothing, local regression, backfitting algorithm.

Multidimensional regression: confidence bounds, model regularization: ridge regression, Least-Absolute-Shrinkage-&-Selection-Operator.

Artificial Neural Networks: Perceptron, multi-layer Perceptron, Backpropagation training, decision functions. Autoregressive ANN, radial basis function. Use in regression & feature extraction.

Unsupervised learning and clustering

Clustering: Unsupervised learning, hierarchical clustering, k-means, fuzzy c-means, mean shift algorithm. Gaussian mixture model, expectation-maximization algorithm, self-organizing maps

Cluster Validation: Cluster validation, number of clusters, distortion measures, Davies-Bouldinindex, other assessment criteria. Novelty detection, ROC curve.

Fundamental Steps in Image Processing: Element of visual perception, a simple image model, sampling and quantization, some basic relationships between pixel, image geometry in 2D, image enhancement in the spatial domain.

Introduction to spatial and frequency methods: Basic gray level transformations, histogram equalization, local enhancement, image subtraction, image averaging, basic spatial, filtering, smoothing spatial filters, sharpening spatial filters.

Books and References:

1. Richard Duda Peter Hart David Stork: Pattern Classification, 2nd ed., Wiley.
2. J. T. Tou and R. C. Gonzalez: Pattern Recognition Principles, Addison-Wesley, London.
3. Christopher Bishop: Pattern Recognition and Machine Learning, Springer.
4. Fukunaga: Introduction to Statistical Pattern Recognition, Second Edition, Academic Press.
5. Gonzalez, R. C. and Woods, R. E.: Digital Image Processing, 3rd ed., Prentice Hall
6. Gonzalez, R. C., Woods, R. E., and Eddins, S. L.: Digital Image Processing Using MATLAB, 2nd ed., Gatesmark Publishing, Knoxville, TN.
7. Anil K. Jain: Fundamentals of digital image processing (2nd Edition), Prentice-Hall, NJ
8. Willian K. Pratt: Digital Image Processing (3rd Edition), , John Wiley & Sons, NY

Paper XIII: Advanced Operating Systems Lab

Shell programming: creating a script, making a script executable, shell syntax (variables, conditions, control structures, functions, commands).

Process: starting new process, replacing a process image, duplicating a process image, waiting for a process, zombie process.

Signal: signal handling, sending signals, signal interface, signal sets.

Semaphore: programming with semaphores (use functions semctl, semget, semop, set_semvalue, del_semvalue, semaphore_p, semaphore_v).

POSIX Threads: programming with pthreadfunctions(viz. pthread_create, pthread_join, pthread_exit, pthread_attr_init, pthread_cancel)

Inter-process communication: pipes (use functions pipe, popen, pclose), named pipes(FIFOs, accessing FIFO)

Paper XIV: Pattern Recognition and Image Processing (Practical)

The course will include six lab sessions requiring programming in one of the following languages:

a. Matlab
b. Octave
c. Python
d. R

Each lab session is generally assigned a two week deadline. Note that the labs are a compulsory part of the course. You are encouraged to work in groups of two during the labs, however you may also choose to work individually. You will be provided assistance throughout the lab periods, and discussions among students and groups are highly recommended

Lab 1: Data visualization, central limit theorem, multivariate normal distribution

Lab 2: Implementation of Hierarchical clustering, k-means

Lab 3: Implementation of Gaussian mixture model, expectation-maximization, Davies-Bouldin index, self-organizing map algorithms.

Lab 4: Implementation of Bayesian classifier, k-NN classifier

Lab 5: Implementation of Linear regression, MMSE, MAP, MLE, quality measures.

Lab 6: Implementation of Nonlinear regression

Lab 7: Image processing using MATLAB

Elective Papers

1. Parallel Computing

Overview, need for parallel computing, basic concepts and terminology -Flynn's classical taxonomy, general parallel terminologies, issues in high performance computing Architecture and interconnection of parallel computers: Memory architectures -shared memory, distributed memory, hybrid distributed-shared memory. Interconnection networks Parallel Programming Models: Overview, shared memory model, threads model, message passing model, data parallel model, advanced Models Designing Parallel Algorithms: Automatic vs. manual parallelization. Partitioning, communications, synchronization, data dependencies, load balancing, granularity, limits and costs of parallel programming, performance analysis and tuning, Processes and processors, Shared memory, Fork, Join constructs, Basic parallel programming techniques-loop splitting, spin locks, contention barriers and row conditions.

Variations in splitting, self and indirect scheduling. Data dependency-forward and backward, block scheduling. Parallel computing examples: array processing, PI calculation, simpleheat equation, matrix vector multiplication, matrix-matrix multiplication, combinational search

Books References:

1. Vipin Kumar, Ananth Gramar, Anshul Gupta, George Kayrips: An Introduction to Parallel Computing : Design and Analysis of Algorithms
2. Brawer, S: Introduction to parallel programming". Academic Press, New York, 1989.
3. Hawang Kai and Briggs F. A.: Computer Architecture and Parallel Processing, McGraw Hill
4. Jorden H. F. and Alaghaband G.: Fundamentals of Parallel Processing.
5. M.J. Quinn: Parallel Programming, TMH

2. Image Processing

Fundamental Steps in Image Processing: Element of visual perception, a simple image model, sampling and quantization, some basic relationships between pixel, image geometry in 2D, image enhancement in the spatial domain.

Introduction to spatial and frequency methods: Basic gray level transformations, histogram equalization, local enhancement, image subtraction, image averaging, basic spatial, filtering, smoothing spatial filters, sharpening spatial filters.

Introduction to the fourier transformation: Discrete fourier transformation, fast fourier transformation, filtering in the frequency domain, correspondence between filtering in the spatial and frequency domain smoothing frequency-domain filters, sharpening frequency domain filters, homomorphic filtering.

Image Segmentation: Line detection, edge detection, gradient operator, edge linking and boundary detection, thresholding, region-oriented segmentation, representation schemes like chain codes.

Some basic morphological algorithms: Dilation and erosion, opening and closing, hit-or-miss transformation, boundary detection, skeleton of a region.

Introduction to Image Compression: Lossy and Lossless Compression techniques, Image Compression Standards, JPEG, MPEG, Wavelets.

Books and References:

1. Gonzalez, R. C. and Woods, R. E.: Digital Image Processing, 3rd ed., Prentice Hall
2. Sonka, M., Hlavac, V., Boyle, R.: Image Processing, Analysis and Machine Vision (2nd edition), PWS Publishing, or (3rd edition) Thompson Engineering, 2007
3. Gonzalez, R. C., Woods, R. E., and Eddins, S. L.: Digital Image Processing Using MATLAB, 2nd ed., Gatesmark Publishing, Knoxville, TN.
4. Anil K. Jain: Fundamentals of digital image processing (2nd Edition), Prentice-Hall, NJ
5. Willian K. Pratt: Digital Image Processing (3rd Edition), , John Wiley & Sons, NY
6. Burger, Willhelm and Burge, Mark J.: Digital Image Processing: An Algorithmic Introduction Using Java, Springer

3. Mobile Computing

Introduction to wireless networking: Advantages and disadvantages of wireless networking

Characteristics of radio propagation: Fading, Multipath propagation

Introduction to digital transmission: Definition of bit-rate and signaling rate. Introduction to synchronous transmission. The need for pulse shaping, synchronization and line-coding. Calculation of bit-error probabilities when the channel is affected by the addition of Gaussian noise.

Narrowband digital modulation: The need for modulation. Binary and multi-level (M-ary) amplitude-shift keying (ASK), frequency-shift keying (FSK) and phase-shift keying (PSK).

Wideband modulation techniques to cope with intersymbol interference: Direct sequence spread spectrum Adaptive Equalization Orthogonal frequency division multiplex

Medium Access Control (MAC): MAC protocols for digital cellular systems such as GSM. MAC protocols for wireless LANs such as IEEE802.11 and HIPERLAN I and II. The near far effect. Hidden and exposed terminals. Collision Avoidance (RTS-CTS) protocols.

Protocols supporting mobility: Mobile network layer protocols such as mobile-IP, Dynamic Host Configuration Protocol (DHCP). Mobile transport layer protocols such as mobile-TCP, indirect-TCP. Wireless Application Protocol (WAP).

Books and References:

1. C. Siva Ram Murthy and B. S. Manoj: Ad Hoc Wireless Networks: Architectures and Protocols,
2. Charles Perkins: Adhoc Networking, , Pearson Education
3. W. Stallings: Wireless Communication

4. **Modeling and simulation**

Systems and environment: Concept of model and model building, model classification and representation, Use of simulation as a tool, steps in simulation study.

Continuous-time and Discrete-time systems: Laplace transform, transfer functions, statespace models, order of systems, z-transform, feedback systems, stability, observability, and controllability.

Statistical Models in Simulation: Common discrete and continuous distributions, Poisson process, and empirical distributions.

Random Numbers: Properties of random numbers, generation of pseudo random numbers, techniques of random number generation, tests for randomness, random variate generation using inverse transformation, direct transformation, convolution method, acceptance-rejection.

Design and Analysis of simulation experiments: Data collection, identifying distributions with data, parameter estimation, goodness of fit tests, selecting input models without data, multivariate an time series input models, verification and validation of models, static and dynamic simulation output analysis, steady-state simulation, terminating simulation, confidence interval estimation, Output analysis for steady state simulation, variance reduction techniques.

Queuing Models: Characteristics of queuing systems, notation, transient and steady-state behavior, performance, network of queues.

Large Scale systems: Model reduction, hierarchical control, decentralized control, structural properties of large scale systems.

Books and References:

1. Jerry Banks, John Carson, Barry Nelson, David Nicol: Discrete Event System Simulation
2. Averill Law, W. David Kelton: Simulation Modeling and Analysis, McGRAWHILL
3. Geffery Gordon: System Simulation, PHI
4. Bernard Zeigler, Herbert Praehofer, Tag Gon Kim: Theory of Modeling and Simulation, Academic Press
5. NarsingDeo: System Simulation with Digital Computer, PHI
6. Donald W. Body: System Analysis and Modeling, Academic Press Harcourt India
7. W David Kelton, Randall Sadowski, Deborah Sadowski: Simulation with Arena, McGRAW-HILL.

5. Natural Language Processing

Regular Expressions and Automata: Introduction to NLP, Regular Expression, Finite State Automata

Tokenization: Word Tokenization, Normalization, Sentence Segmentation, Named Entity Recognition, Multi Word Extraction, Spell Checking – Bayesian Approach, Minimum Edit Distance

Morphology: Morphology – Inflectional and Derivational Morphology, Finite State Morphological Parsing, The Lexicon and Morphotactics, Morphological Parsing with Finite State Transducers, Orthographic Rules and Finite State Transducers, Porter Stemmer

Language Modeling: Introduction to N-grams, Chain Rule, Smoothing – Add-One Smoothing, Witten-Bell Discounting; Backoff, Deleted Interpolation, N-grams for Spelling and Word Prediction, Evaluation of language models.

Hidden Markov Models and POS Tagging: Markov Chain, Hidden Markov Models, Forward Algorithm, Viterbi Algorithm, Part of Speech Tagging – Rule based and Machine Learning based approaches, Evaluation

Text Classification: Text Classification, Naïve Bayes' Text Classification, Evaluation, Sentiment Analysis – Opinion Mining and Emotion Analysis, Resources and Techniques

Context Free Grammar: Context Free Grammar and Constituency, Some common CFG phenomena for English, Top-Down and Bottom-up parsing, Probabilistic Context Free Grammar, Dependency Parsing

Computational Lexical Semantics: Introduction to Lexical Semantics – Homonymy, Polysemy, Synonymy, Thesaurus –WordNet, Computational Lexical Semantics – Thesaurus based and Distributional Word Similarity

Information Retrieval: Boolean Retrieval, Term-document incidence, The Inverted Index, Query Optimization, Phrase Queries, Ranked Retrieval – Term Frequency – Inverse Document Frequency based ranking, Zone Indexing, Query term proximity, Cosine ranking, Combining different features for ranking, Search Engine Evaluation, Relevance Feedback

Books and References:

1. Jurafsky and Martin, Speech and Language Processing, Pearson Education
2. Manning and Schutze, Foundation of Statistical Natural Language Processing, MIT Press Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, O'Reilly Media

6. Data Mining and Data Warehousing

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, Architectures of Data Mining Systems.

Data Warehouse : Introduction, A Multidimensional data Model, Data Warehouse Architecture, Data Warehouse Implementation, Data Cube Technology, From Data warehousing to Data Mining.

Data Processing: Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and concept Hierarchy Generation.

Concept Description: Data Generalization & Summarization – Based Characterization, Analytical Characterization, Mining class Comparisons, Mining Descriptive Statistical Measures in Large Databases.

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.

Classification and Prediction: Classification & Prediction, Issues Regarding Classification & Prediction, Classification by decision Tree Induction, Bayesian Classification, Classification by Back propagation, Prediction, Classification Accuracy.

Cluster Analysis: Types of Data in Cluster Analysis, Partitioning methods, Hierarchical methods, Density – Based Methods, Grid – Based Methods, Model – Based Clustering Methods, Outlier Analysis.

Web Mining: Web data: collection and interpretation, analyzing user browsing behavior learning from click-through data, predictive modeling and online advertising, link analysis and the PageRank algorithm

Social Network Analysis: descriptive analysis of social networks, network embedding and latent space models, network data over time: dynamics and event-based networks, link prediction

Books and References:

1. J. Han and M. Kamber: Data Mining: Concepts and Techniques, 2nd Ed. Morgan Kaufman. 2006.
2. M. H. Dunham: Data Mining: Introductory and Advanced Topics. Pearson Education. 2001.
3. I. H. Witten and E. Frank: Data Mining: Practical Machine Learning Tools and Techniques. Morgan Kaufmann. 2000.
4. D. Hand, H. Mannila and P. Smyth: Principles of Data Mining. Prentice-Hall. 2001.

7. Cryptography

Introduction: History and overview of cryptography

Identification protocols: Password protocols, salts, PBKDF2; one time passwords (S/Key and SecurID); challenge response authentication.

Basic symmetric-key encryption:

One time pad and stream ciphers: perfect secrecy and the one time pad, semantic security and stream ciphers.

Block ciphers: Case studies: Feistel networks, DES, 3DES, and AES; basic modes of operation: CBC and counter mode.

Block cipher abstractions: Pseudo Random Permutations (PRP); Pseudo Random Functions (PRF); security against chosen plaintext attacks (CPA); nonce-based CBC encryption and nonce-based counter mode.

Attacks on block ciphers: exhaustive search, time-space tradeoffs, differential & linear cryptanalysis, meet in the middle, side channels.

Message integrity:

Message integrity: CBC-MAC and PMAC.

Collision resistant hashing: Merkle-Damgard and Davies-Meyer. MACs from collision resistance. Case studies: SHA and HMAC.

Authenticated encryption: intro to session setup using a key distribution center (KDC).

Public key cryptography:

Arithmetic modulo primes

Cryptography using arithmetic modulo primes: vanilla key exchange (Diffie-Hellman); the CDH and discrete-log assumptions

Public key encryption: semantically secure ElGamal encryption; CCA security

Arithmetic modulo composites: RSA and Rabin functions, how to encrypt with trapdoor permutations.

Digital signatures:

Digital signatures: How to sign using RSA.

More signature schemes: Lamport and Merkle schemes, overview of signatures based on discrete-log, certificates and trust management.

Final topics: Real world crypto: SSL/TLS and IPsec, The EMV payment protocol

Books and References:

1. J. Katz and Y. Lindell: Introduction to Modern Cryptography, Chapman & Hall/CRC Press
2. A. Menezes, P. Van Oorschot, S. Vanstone: Handbook of Applied Cryptography
3. J. Pieprzyk, T. Hardjono and J. Seberry: Fundamentals of Computer Security, Springer
4. D. Stinson: Cryptography: Theory and Practice, CRC Press
5. B. Schneier: Applied Cryptography: Protocols, Algorithms, and Source Code in C, Wiley

8. Embedded Systems

Introduction and Hardware Environment: Overview of embedded system, categories of embedded system, processor technology, design technology, applications : consumer electronics, control & industrial automation, network information appliances, wireless communications Hardware architecture : processor, memory, latches, buffers, ports, timers, counters, watchdog timers, UART, pulse width modulators, LCD controllers, keypad controllers, stepper motor controllers, analog-to-digital converters, real time clocks.

Communication Principles : Parallel, serial, wireless and layering, Protocols : 12C, CAN, FireWire, USB, PCI bus, ARM bus, IrDa, Bluetooth, IEEE 802.11, operating system, kernel architecture, embedded operating system, context switch, task synchronization, real time and mobile operating system, programming languages, development tools for host & target machines, embedded system development system, interrupt basics, interrupt handling.

VC++ Programming Introduction to MFC & windows: MFC fundamentals, processing messages, message boxes, menus, dialog boxes, common controls (Radio buttons, check boxes, scroll bars, buttons, cursor, icons, managing texts), properties sheet.

Project Studies: Simple LED blinking program, device driver programming, serial communication programming for PC-to-PC communication, development of navigation system, protocol converter.

Books and References:

1. Dr. Prasas, Vikas Gupta, Das &Verma: Programming for embedded system, WILEY Dreamtechindia Pvt.
2. Frank Vashid& Tony Givergis: Embadded System Design.,WILEY.
3. Herbert Schildt: MFC Programming.,TataMcGraw Hill.
4. David E. Simon: An Embedded software primer Low Price Edition.
5. Michael Barr: Programming Embedded Systems. O'REILLY

9. Bio-Informatics

Introduction to Bioinformatics: Central dogma of Molecular Biology

Biological Databases: Concepts and Understanding

Sequence alignment: Global and local alignment, scoring, dynamic programming, tree alignment, Hidden Markov Models

Gene finding algorithms

Protein Sequences and Substitution matrices: Suffix tree construction and applications

Introduction to Gene Expression: Microarrays, their uses, idea about normalization

Single Nucleotide Polymorphisms (SNPs): The Haplotype problem

Phylogenetic Tree and Analysis

Introduction to Gene Regulation: Gene regulation, binding sites, transcriptional networks, gene's circuitry

Network of Interactions: Regulatory networks

Signals in Sequences: Weight matrices, higher order MC dependencies, transcription, factor binding sites

Introduction to Proteomics: Protein structure, interactions

Protein Structure Prediction: Attempts to predict secondary and tertiary structure of amino acid sequences

Drug docking

Books and References:

1. N. Jones and P. Pevzner: An Introduction to Bioinformatics Algorithms, MIT Press
2. Dan Gusfield: Algorithms on Strings, Trees, and Sequences, Cambridge University Press, 1997
3. Richard Durbin, Sean R Eddy, Anders Krogh, Graeme Mitchison: Biological Sequence Analysis, Cambridge, 1998
4. Roderic D M Page, Edward C Holmes. Molecular Evolution: A phylogenetic Approach, Blackwell Sciences Inc 1999
5. David W Mount: Bioinformatics: Sequence and Genome Analysis, CBS Publishers and Distributors (Pvt.) Ltd., 2005
6. Pierre Baldi, Soren Brunak: Bioinformatics: The Machine Learning Approach, MIT Press, 2001

10. Machine Learning

Introduction: Basic concepts.

Supervised learning: Supervised learning setup. LMS; Logistic regression. Perceptron. Exponential family; Generative learning algorithms. Gaussian discriminant analysis. Naive Bayes; Support vector machines; Model selection and feature selection; Ensemble methods: Bagging, boosting; evaluating and debugging learning algorithms.

Learning theory: Bias/variance tradeoff. Union and Chernoff/ Hoeffding bounds; VC dimension. Worst case (online) learning; Practical advice on how to use learning algorithms.

Unsupervised learning: Clustering. K-means; EM. Mixture of Gaussians; Factor analysis; PCA (Principal components analysis); ICA (Independent components analysis).

Reinforcement learning and control: MDPs. Bellman equations; Value iteration and policy iteration; Linear quadratic regulation (LQR). LQG; Q-learning. Value function approximation; Policy search. Reinforce. POMDPs.

Books and References:

1. Tom Mitchell: Machine Learning, McGraw-Hill
2. E. Alpaydin, Introduction to Machine Learning, Prentice Hall of India, 2006.
3. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
4. R. O. Duda, P. E. Hart, and D.G. Stork, Pattern Classification, John Wiley and Sons, 2001.
5. Vladimir N. Vapnik, Statistical Learning Theory, John Wiley and Sons, 1998.
6. Shawe-Taylor J. and Cristianini N., Cambridge, Introduction to Support Vector Machines, University Press, 2000.

11. Information Security

Overview of Security: Protection versus security; aspects of security–data integrity, data availability, privacy; security problems, user authentication, Orange Book.

Security Threats: Program threats, worms, viruses, Trojan horse, trap door, stack and buffer overflow; system threats- intruders; communication threats- tapping and piracy.

Cryptography: Substitution, transposition ciphers, symmetric-key algorithms-Data Encryption Standard, advanced encryption standards, public key encryption - RSA; Diffie-Hellman key exchange, ECC cryptography, Message Authentication- MAC, hash functions.

Digital signatures: Symmetric key signatures, public key signatures, message digests, public key infrastructures.

Security Mechanisms: Intrusion detection, auditing and logging, tripwire, system-call monitoring.

Books and References:

1. W. Stalling, Cryptography and Network Security Principles and Practices (4th ed.), Prentice-Hall of India, 2006.
2. C. Pfleeger and SL Pfleeger: Security in Computing (3rd ed.), Prentice-Hall of India, 2007.
3. D. Gollmann: Computer Security, John Wiley and Sons, NY, 2002.
4. J. Piwprzyk, T. Hardjono and J. Seberry: Fundamentals of Computer Security, Springer-Verlag Berlin, 2003.
5. J.M. Kizza: Computer Network Security, Springer, 2007.
6. M. Merkow and J. Breithaupt, Information Security: Principles and Practices, Pearson Education, 2006.

12. Multimedia Technology

Introduction: Multimedia and its Application, Different Media, Hypertext and Hypermedia, Issues in Multimedia System, Component of a Multimedia System

Overview of Text and Graphics:

Types of Text Data (Plain/Formatted/Hypertext), Unicode Scheme, Concept of Font, File Formats (txt, doc, rtf, ps, pdf etc.), Vector and Raster Graphics, Image Digitization, Digital Image, Binary/ Gray-Scale/ Color Image, Color Models, File Formats, Overview of Contrast Intensification, noise removal, edge detection and segmentation

Image Descriptors (Shape, Texture and Colour Features)

Loss-less and Lossy Image Compression including JPEG

An overview of Content Based Image Retrieval System

Audio: Audio Digitization (Sampling and Quantization, Representation based onPCM/DPCM/DM/ADM), File Formats

Time Domain Descriptors (ZCR, STE etc.), Frequency Domain Descriptors (Spectral Centroid, Spectral Flux, Spectral Roll Off etc.), and Perception based Descriptors (Mel Scale, MFCC)

Psycho Acoustics and Audio Compression

An Overview of Audio Classification/Retrieval System

Video: Structure of Video Data, File Formats, Video Compression, Motion Estimation, Structural Segmentation of Video Data, Overview of Video Summarization, Browsing and Retrieval System

Animation: Keyframes & tweening, cel & path animation, principles and techniques of animation, Web animation, 3D animation principles, camera, special effects, transformations and editing, rendering algorithms, features of animation software, file formats.

Books and References:

1. J. Keyes: Multimedia Handbook, MH.
2. G. Blair, L. Blair, A. Chetwynd, H. Bowman: Formal Specification of Distributed Multimedia Systems, UCL Press, London.
3. S. Khoshafian, A. Brad Baker: Multimedia and Imaging Databases, Morgan Kaufmann.
4. Buford J. K: Multimedia Systems, Pearson Education.
5. Jennifer Burg: The Science of Digital Media, Prentice Hall

13. Social Network Analysis

Introduction of Social Network Components: nodes, edges, adjacency matrix, one and two-mode networks, node degree

Random network models: connected components, giant component, average shortest path, diameter, breadth-first search, preferential attachment, Create random networks, calculate component distribution, average shortest path, and evaluate impact of structure on ability of information to diffuse

Network centrality: betweenness, closeness, eigenvector centrality (+ PageRank), network centralization**,** calculate and interpret node centrality for real-world networks (your Facebook graph, the Enron corporate email network, Twitter networks, etc.)

Community: clustering, community structure, modularity, overlapping communities**,** detect and interpret disjoint and overlapping communities in a variety of networks (scientific collaborations, political blogs, cooking ingredients, etc.)

Small world network models, optimization, strategic network formation and search: small worlds, geographic networks, decentralized search**,** Evaluate whether several real-world networks exhibit small world properties, simulate decentralized search on different topologies, evaluate effect of small-world topology on information diffusion.

Contagion, opinion formation, coordination and cooperation: simple contagion, threshold models, opinion formation**,** Evaluate via simulation the impact of network structure on the above processes

Some applications of SNA

SNA and online social networks: how services such as Facebook, LinkedIn, Twitter, Couch Surfing, etc. are using SNA to understand their users and improve their functionality

Books and References:

1. J. Scott: Social network analysis: A handbook (2nd Ed.), Sage Publications
2. T. W. Valente: Network models of the diffusion of innovations, Hampton Press.
3. S. Wasserman, & K. Faust: Social networks analysis: Methods and applications. New York: Cambridge University
4. Linton Freeman: The Development of Social Network Analysis: A Study in the Sociology of Science. Empirical Press of Vancouver, BC, Canada

14. Game Theory

Introduction: Introduction, overview, uses of game theory, some applications and examples, and formal definitions of: the normal form, payoffs, strategies, pure strategy Nash equilibrium, dominated strategies.

Mixed-strategy Nash equilibria: Definitions, examples, real-world evidence.

Alternate solution concepts: iterative removal of strictly dominated strategies, minimax strategies and the minimax theorem for zero-sum game, correlated equilibria.

Extensive-form games: Perfect information games: trees, players assigned to nodes, payoffs, backward Induction, subgame perfect equilibrium, introduction to imperfect-information games, mixed versus behavioral strategies.

Repeated games: Repeated prisoners dilemma, finite and infinite repeated games, limited-average versus future-discounted reward, folk theorems, stochastic games and learning.

Coalitional games: Transferable utility cooperative games, Shapley value, Core, applications.

Bayesian games: General definitions, ex ante/interim Bayesian Nash equilibrium.

Books and References:

1. Kevin Leyton-Brown, YoavShoham, Ronald J Brachman, Ronald Brachman and Thomas Dietterich: Essentials of Game Theory, 1st Edition, Morgan and Claypool Publishers, 2008
2. Matthew O. Jackson: A Brief Introduction to the Basics of Game Theory
3. Noam Nisan, Tim Roughgarden, Eva Tardos, Vijay V. Vazirani, Algorithmic Game Theory, Cambridge University Press, September 2007.
4. Ronald Cohn Jesse Russell, Algorithmic Game Theory, VSD Publishers, 2012.

15. Bigdata Analytics

Introduction to Big Data Analytics: Big Data Overview, State of the Practice in Analytics, Big Data Analytics in Industry Verticals, Data Analytics Lifecycle

Review of the Basic Data Analytic Methods using R: Introduction to R – look at the data, Analyzing and Exploring the Data, Statistics for Model Building and Evaluation

Analytics: K-means clustering, Association rules, Linear Regression, Logistic Regression, Naïve Bayes, Decision Trees, Time Series Analysis, Text Analysis

Advanced Analytics: Analytics for Unstructured Data (MapReduce and Hadoop), The Hadoop Ecosystem, In-database Analytics – SQL Essentials, Advanced SQL and MADlib for in-database Analytics

Putting All Together: Operationalizing an Analytics Project, Creating the Final Deliverables, Data Visualization Techniques

Books and References:

1. Viktor Mayer-Schönberger, Kenneth Cukier:BigData,Hodder& Stoughton
2. O'Reilly Media Inc: Big Data Now, Shroff And O'Reilly
3. Bill Schmarzo: Big Data : Understanding How Data Powers Big Business (English) 1st Edition, Wiley
4. VigneshPrajapati: Big Data Analytics with R and Hadoop (English) 1st Edition, Shroff / Packt

16. Human Computer Interaction

Introduction: Introduction to Human Computer Interaction, The power of Prototyping, Evaluating Designs, The Birth of HCI

Neddfinding: Participant Observation, Interviewing, Additional Needfinding strategies, Creating Design Goals

Rapid Prototyping: Storyboards, Paper Prototypes, and Mockups, Faking it -- Wizard of Oz, Faking it Video Prototyping**,** Creating and Comparing Alternatives

Heuristic Evaluation: Heuristic Evaluation — Why and How? Design Heuristics

Direct Manipulation and Representations: Direct Manipulation, Mental Models, Representations Matters, Distributing Cognition

Visual Design and Information Design: Visual Design, Typography, Grids and Alignment, Reading and Navigating

Designing experiments: Designing Studies That You Can Learn From, Assigning Participants to Conditions, In-Person Experiments, Running Web Experiments, Comparing Rates

Books and References:

1. Alan Dix: Human-Computer Interaction, Pearson Education
2. Yvonne Rogers, Helen Sharp, Jenny Preece: Interaction Design: Beyond Human-Computer Interaction, Wiley India Pvt Ltd
3. Donald A. Norman: The Design of Everyday Things, PERSEUS BOOKS GROUP

17. Computational Intelligence:

Introduction to Computational Intelligence, Computational Intelligence vs Artificial Intelligence.

Rough Sets: Introduction, Set Approximation, Decision Tables.

Fuzzy Logic Systems: Notion of fuzziness, fuzzy modeling, operations on fuzzy sets, T-norms and other aggregation operators, basics of approximate reasoning, compositional rule of inference, fuzzy rule based systems, (Takagi-Sugeno and Mamdani-Assilian models), schemes of fuzzification, inferencing, defuzzificatin, fuzzy clustering, fuzzy rule based classifier.

Artificial Neural Networks: The neuron as a simple computing element, the Perceptron, Multilayer Neural Networks, Supervised Learning Neural Networks, Unsupervised Learning Neural Networks, Radial Basis Function Networks, Reinforcement Learning

Evolutionary Computation: Genetic operators, building block hypothesis, evolution of structure, genetic algorithms based on tree and linear graphs, applications in science and engineering.

Books and References:

1. Leszek Rutkowski, Computational Intelligence: Methods and Techniques, Springer, 2008.
2. Andries P. Engelbrecht, Computational Intelligence: An Introduction, John Wiley and Sons, 2007.
3. K.H. Lee, First Course on Fuzzy Theory and Applications, Springer, 2005
4. D. E. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley, Reading, 1989
5. E. Alpaydin, Introduction to Machine Learning, Prentice-Hall of India, 2004
6. Amit Konar, Computational Intelligence: Principles, Techniques and Applications, Springer, 2005.

18. Quantum Computation

Introduction to quantum mechanics: Hilbert space, Unitary and stochastic dynamics, Probabilities and measurements, Entanglement, Density operators and correlations

Introduction to quantum information: Classical information theory, Quantum information types and quantum channels, Dense coding, Teleportation, No cloning, Quantum cryptography

Quantum algorithms: Classical computation, Shor's Algorithm, Grover search, Measurement-based computation

Physical realizations: Optical lattices

Noise and error correction: Quantum operations, Graph states and codes, Quantum error correction, Fault-tolerant computation

Books and References:

1. M. A. Nielsen and I. L. Chuang: Quantum Computation and Quantum Information, Cambridge
2. R. B. Griffiths: Consistent Quantum Theory, Cambridge