UNIVERSITY OF HYDERABAD

PhD
COURSE CURRICULUM

School of Computer and Information Sciences

UNIVERSITY OF HYDERABAD
School of Computer and Information Sciences

Guidelines for Ph.D Course Work and Syllabus

1. One or maximum two broad areas or topics will be decided at the time of Entrance Examination (that is, viva). The candidate will write and sign this up. Within a month of registration of the candidate, a supervisor will be decided and a DRC will be constituted. Need for change of topic or guide at a later point of time will be viewed as an exceptional case and will be handled as per existing rules.

2. All candidates admitted to PhD in the School, whether full time, part time or external, are required to pass a comprehensive examination within a period of 1 year from the date of admission. Initial Admission is Provisional and subject to candidate passing the comprehensive. In case a candidate is unable to pass the comprehensive exam within 1 year and 1 month, his/her admission stands automatically canceled.

   The comprehensive exam will be a written exam and will consist of four papers. Each paper will be for 100 marks. There is no concept of internal marks.

   Core Courses: (Mandatory)
   1. Data Structure and Algorithms
   2. Operating System and Programming

   Elective Courses: (Any Two)
   3. High Performance Computing
   4. Digital Image Processing
   5. Pattern Recognition
   6. Spoken Language Processing
   7. Human Computer Interaction
   8. Secure Computing
   9. Trends in Software Engineering
   10. Theory Logic and Model of Computation
   11. Advanced Networking
   12. Trends in Softcomputing
   13. Learning & Reasoning
   14. Natural Language Processing
   15. Metaheuristic Techniques
   16. Mobile Computing
   17. Datamining
   18. Bioinformatics

   The elective courses will relate to research interests of the School. The DRC can suggest and counsel the candidates as to which of these electives are best suited for them.

3. The study material for each course is given in reference section. You need to arrange study material on your own. The School will not provide the same. These are all self-study courses, there will be no classes/tutorials etc. Nevertheless, all candidates regardless of mode (Full-time, Part-time, External) will be free to audit on going courses for MTechs/MCAs.
4. The School faculty will be available on the 3rd Saturday of every month for interaction with research scholars. The morning sessions could be used for general matters and topics relating to core courses and afternoons can be devoted to discussions with concerned faculty on chosen areas of specialization (Elective Courses).
5. Passing the comprehensive examination means passing each of the papers with a minimum of 50% mark.
6. Comprehensive exams will be conducted twice a year, ie. in January and July. All the four papers can be cleared in a single sitting or can be cleared in two different sittings.
7. Supplementary examination will be conducted once in a year say before 20th of August every year. Students of the last year can take supplementary examination for the course he/she has failed.

Paper Name: Data Structure and Algorithms

Content

Data Structures: Primitive and Composite Data types, Stacks, Queues, Arrays, Linked Lists, Trees and Graphs. Application of Data structures.

Algorithms; Asymptotic Notation; Analysis of Algorithms; Time and Space Complexity of Algorithms, Solving recurrences; Greedy Algorithms, Spanning trees, shortest paths, knapsack problem, scheduling problem; Divide-and-conquer, Searching & Sorting Algorithms. Dynamic programming principle of optimality; Graph Algorithms, BFS, DFS, Back tracking, Branch and Bound; Computation Complexity, Introduction to NP-completeness; Examples and brief overview of heuristic.

Text Books:

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++(3rd edition)", Addison-Wesly, 2007.
2. E. Horowitz and S. Sahni, "Fundamentals Of Data Structures In C++ ", Universities Press (india) Limited (Paperback) 2008
3. G. Brassard and P. Bratley, "Fundamentals of Algorithms" PH India 1997.
4. E. Horowitz, Sahni Sartaj & Rajasekaran Sanguthevar, "Fundamentals Of Computer Algorithms", Universities Press (India) (Paperback) 2008
5. T.H. Cormen, C E Leiserson, R. Rivest "Introduction to Algorithms", PH India 1998.
6. Michael T. Goodrich and Roberto Tamassia "Data Structures and Algorithms in Java(4th edition)" John Wiley & Sons, Inc, 2006

Paper Name: Operating System and Programming

Content

OS

Introduction: History, Evolution and Philosophy, Hardware evolution, Economic Forces and constraints, Structuring methods, Layered model, object - server model, Application needs and significant case histories.

Process Management: Tasks/Processes, Processes Structures: ready list, process control block etc., Dispatching, content switches, Role of interrupts.

Process Synchronization: Process co-ordination and synchronization, Concurrent execution, Sharing access, race conditions, Deadlock: Causes, Conditions, Prevention Models and mechanisms (eg. Busy waiting, spin locks, Dekker's algorithm, semaphores, mutex locks, region, monitors).

Scheduling and Dispatch: Preemptive and non-preemptive scheduling, schedules and policies.

Memory Management: Physical and Virtual Memory Organization, Physical memory and registers, Overlays, swapping, partitions Pages and segments, Placement and replacement policies, Thrashing, working sets.

Device Management: Free lists, layout Servers, interrupts, Recovery from failures.

File Systems: Basic Concepts (eg: Naming, Organization , Access, Manipulation), Disk space allocation and free space management techniques, RAID structure, Case studies of XFS, NTFS, EXT3 and ZFS.

I/O Subsystem: Application I/O interface, kernel I/O subsystem, synchronous and asynchronous I/O, device drivers, STREAMS.

Virtualization: What is virtualization? Why do we need virtualization? Models of virtualization, Hardware support for virtualization, I/O virtualization, Case study: Xen.

Programming

Problem Analysis, flow Charts, decision tables. Pseudo codes and Algorithms, High level language and Programmer's Model of Computer System. Algorithmic Programming Language: Representation of integers, reals, characters, constants and variables, arithmetic expressions and their evaluation using rules of hierarchy. Assignment statements, Logical constants variables and expression Control structures - sequencing alteration, iteration. Arrays, Manipulating vectors and matrices. Subroutines overhead cost, interpretation of the variances. Compiling, debugging and testing in integrated development environment.

Text Books:

1. Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne, "Operating System Concepts", Addison Wesley, 8th edition, 2008.
2. Andrew. S Tanenbaum, "Modern Operating Systems, 3rd Edition, Prentice-Hall, Inc., 2008.
3. William Stallings, "Operating Systems: Internals and Design Principles" Prentice-Hall, Inc., 6th Edition, 2008.
4. Brian W. Kernighan. and Dennis Richie, "The C programming language", PHI, 2nd edition, 1988.

5. Michael Schneider, Steven W. Weingart, David M. Perlman, “An Introduction to Programming and Problem Solving With Pascal”, John Wiley and Sons Inc., 1984.
6. R.G. Dromey, “How to solve it by Computer”, Prentice-Hall International Series in Computer Science, 1982.
7. David Gries, “T**he Science of Programming”,** Springer Verlag, 1981.

Paper Name: High Performance Computing

Contents

1. Introduction to Parallel Computing:

Why Parallel Computing & Scope of Parallel Computing, Sieve of Eratosthenes, Control and Data Approach, PRAM model of parallel computation, Design paradigms of Parallel Computing, examples, Bulk Synchronous Parallel (BSP) model, algorithms on PRAM and BSP model. Analytical Modeling of Parallel Programs, Sources of Overhead in Parallel Programs, Performance Metrics for Parallel Systems, Effect of Granularity and Data Mapping on Performance, Scalability of Parallel Systems, Minimum Execution Time and Minimum Cost-Optimal Execution Time, Asymptotic Analysis of Parallel Programs, Other Scalability Metrics

2. Practical Parallel Programming Paradigms:

Foster's design paradigm for Multi computing programming, Programmability Issues, Programming Models: Message passing, Message passing standards: PVM (Parallel Virtual Machine), MPI (Message Passing Interface) and its routines, Advanced Features of MPI, Load balancing techniques. Programming on Multiprocessors: Introduction to OpenMP (History, Overview, Programming Model, OpenMP Constructs, Performance Issues and examples, Explicit Parallelism: Advanced Features of OpenMP).

3. Threading on Intel Multi-Core Processors

Hardware-based Threading, Hyper-Threading Technology

Difference between Multiprocessor and Hyper-Threading, Technology, Hyper-Threading Technology Architecture, Multi-Core Processors, Architectural Details, Comparison between Multiprocessors and Multi-Core, Processors, Multiple Processor Interaction, Inter-Processor Communication and Multi-threaded Programming, Power Consumption, Power Metrics.

4. Heterogeneous Multi-Core Programming with CUDA

Introduction to GPU Computing, CUDA Programming Model, CUDA API, Simple Matrix Multiplication in CUDA, CUDA Memory Model, Shared Memory Matrix Multiplication, Additional CUDA API Features, Threading Hardware, Memory Hardware, Memory Bank Conflicts, Parallel Thread Execution, Control Flow, Precision.

5. Dense Matrix Algorithms

Matrix-Vector Multiplication, Matrix-Matrix Multiplication, Solving a System of Linear Equations.

6. Sorting

Issues in Sorting on Parallel Computers Sorting Networks Bubble Sort and its Variants, Quicksort Bucket and Sample Sort Other Sorting Algorithms.

7. Graph Algorithms

Definitions and Representation, Minimum Spanning Tree: Prim's Algorithm, Single-Source Shortest Paths: Dijkstra's Algorithm, All-Pairs Shortest Paths, Transitive Closure

Connected Components, Algorithms for Sparse Graphs.

Books:

1. Quinn, M. J., Parallel Computing: Theory and Practice (McGraw-Hill Inc.).
2. Bary Wilkinson and Michael Allen: Parallel Programming Techniques using Networked of workstations and Parallel Computers, Prentice Hall, 1999.
3. W. Gropp, E. Lusk, N. Doss, A. Skjellum, A high performance portable implementation of the message passing Interface (MPI) standard, Parallel Computing 22 (6), Sep 1996.
4. Gibbons, A., W. Rytter, Efficient Parallel Algorithms (Cambridge Uni. Press).
5. Programming Massively Parallel Processors: A Hands-on Approach, authors, David B. Kirk, Wen-mei W. Hwu, Morgan Kaufmann, 2010 (This book is only on NVIDIA GPUs and CUDA programming despite its title)
6. CUDA by Example: An Introduction to General-Purpose GPU Programming by Jason Sanders and Edwards Kandrot Addison-Wesley, 2011.
7. CUDA Programming A Developer's Guide to Parallel Computing with GPUs Shane Cook, Morgan Kaufmann
8. Introduction to Parallel Computing, Second Edition ByAnanth Grama, Anshul Gupta, George Karypis, Vipin Kumar. Publisher: Addison Wesley, 2011.

Paper Name: Digital Image Processing

Contents

IMAGE PROCESSING

Introduction to Image processing, Fundamentals of Imaging, Imaging systems, Projection Geometry, Imaging model: radiometric models, geometric models, sampling and quantization, tessellation, image models; Image File Formats, Colour Maps and Tables. Image Transforms: Fourier, Walsh, Haar, Hotelling etc, Image Enhancement: Spatial Operations including point Processes (histogram equalization, specification), windowing etc. Frequency Domain Operations for Noise removal, contrast enhancements etc, Image Restorations: model estimation, Motion blurr, de-focus: Wiener, inverse filter etc. Image compression: Lossless, lossy etc. Mathematical Morphology, Basic Algorithms, Advanced Topics and Applications. Color Image Processing: Fundamentals

Text Books:

1. Digital Image Processing by Gonzalez and Woods, 3rd Edition, Addison-Wesley, 2008

Paper Name: Pattern Recognition

Contents

STATISTICAL PATTERN RECOGNITION

Introduction, Gaussian model, discriminant functions, classifier performance, risk and errors; Supervised learning using parametric and nonparametric approaches: ML estimation, Bayesian parameter estimation approach, Parzen Windows, k-nn estimation; Unsupervised learning and clustering: the clustering concept, c-means algorithm, learning vector quantization, clustering strategies, a hierarchical clustering procedure.

SYNTACTIC PATTERN RECOGNITION

Introduction to formal languages;String languages for pattern recognition: selection of pattern primitives, patterns grammars, PDL,. Transition network grammar for pattern description, Automated transition nets (ATNs); Higher dimensional grammars: Web and graph grammars, tree grammars, grammar describing 3-D objects;Syntax analysis as a recognition procedure: parsing, top-down parsing, bottom-up parsing, Cocke-Youngee Kasami (CKY) parsing algorithm, Earley's parsing algorithms, LL(k) and LR(k) grammars;Stochastic languages for syntactic pattern recognition: basic formulation, probability measures associated with linear and context-free grammar, languages accepted by stochastic automata, stochastic programmed and indexed grammars.

STRUCTURAL PATTERN RECOGNITION

Graphs and grid: fundamentals of graph theory, basic algorithms for graphs, fundamentals of discrete geometry, connectivity and topology; Segmentation: edge, region and texture; Boundary representation: projection, Fourier descriptors; Region representation: shape descriptors, mask and moments, thinning, MAT: Scene analysis methods. Constraint Satisfaction, etc.

Text Books:

1. Duda R O and P E Hart, Patten classification and scene analysis, John Wiley & Sons, NY 1973
2. Andrew R. Webb, Statistical Pattern Recognition, Second Edition, 2002, John Wiley and Sons Ltd.
3. K.S.Fu, Syntactic pattern recognition and applications, Prentice Hall, NJ, 1982
4. T.Pavlidis, Structural pattern recognition, Springer-Verlag, NY, 1977

Paper Name: Spoken Language Processing

Content

1. Introduction.

Motivations. Spoken Language System Architecture.

I. FUNDAMENTAL THEORY.

2. Spoken language Structure.
Sound and Human Speech Systems. Phonetics and Phonology. Syllables and Words. Syntax and Semantics.

3. Probability, Statistics, and Information Theory.
Probability Theory. Estimation Theory. Significance Testing. Information Theory.

4. Pattern Recognition.
Bayes' Decision Theory. How to Construct Classifiers. Discriminative Training. Unsupervised Estimation Methods. Classification and Regression Trees.

II. SPEECH PROCESSING.

5. Digital Signal Processing.
Digital Signals and Systems. Continuous-Frequency Transforms. Discrete-Frequency Transforms. Digital Filters and Windows. Digital Processing of Analog Signals. Multirate Signal Processing. Filterbanks. Stochastic Processes.

6. Speech Signal Representations.
Short-Time Fourier Analysis. Acoustical Model of Speech Production. Linear Predictive Coding. Cepstral Processing. Perceptually Motivated Representations. Formant Frequencies. The Role of Pitch.

7. Speech Coding.
Speech Coders Attributes. Scalar Waveform Coders. Scalar Frequency Domain Coders. Code Excited Linear Prediction (CELP). Low-Brit Speech Coders.

III. SPEECH RECOGNITION.

8. Hidden Markov Models.
The Markov Chain. Definition of the Hidden Markov Model. Continuous and Semicontinuous HMMs. Practical Issues in Using HMMs. HMM Limitations.

9. Acoustic Modeling.
Variability in the Speech Signal. How to Measure Speech Recognition Errors. Signal Processing—Extracting Features. Phonectic Modeling—Selecting Appropriate Units. Acoustic Modeling—Scoring Acoustic Features. Adaptive Techniques—Minimizing Mismatches. Confidence Measures: Measuring the Reliability. Other Techniques.

10. Lexical modeling.

Pronunciation lexicon, pronunciation variations, Morphology and Finite-State Transducers, Computational Phonology and Pronunciation Modeling, Probabilistic Models of Pronunciation and Spelling

11. Language Modeling.

Formal Language Theory. Stochastic Language Models. Complexity Measure of Language Models. N-Gram Smoothing. Adaptive Language Models.

12. Basic Search Algorithms.

Basic Search Algorithms. Search Algorithms for Speech Recognition. Language Model States. Time-Synchronous Viterbi Beam Search. Stack Decoding (A Search).

13. Large-Vocabulary Search Algorithms.

Efficient Manipulation of a Tree Lexicon. Other Efficient Search Techniques. N-Best and Multi-pass Search Strategies. Search-Algorithm Evaluation.

IV. TEXT-TO-SPEECH SYSTEMS.

14. Text and Phonetic Analysis.

Modules and Data Flow. Lexicon. Document Structured Detection. Text Normalization. Linguistic Analysis. Homograph Disambiguation. Morphological Analysis. Letter-to-Sound Conversion. Evaluation. Case Study: Festival.

15. Prosody.

The Role of Understanding. Prosody Generation Schematic. Speaking Style. Symbolic Prosody. Duration Assignment. Pitch Generation. Prosody Markup Languages. Prosody Evaluation.

16. Speech Synthesis.

Attributes of Speech Synthesis. Formant Speech Synthesis. Concatenative Speech Synthesis. Prosodic Modification of Speech. Source-Filter Models for Prosody Modification. Evaluation of TTS Systems.

REFERENCES

1. Xuedong Huang, Alex Acero and Hsiao-Wuen Hon, Spoken Language Processing: A Guide to Theory, Algorithm and System Development, Prentice Hall ISBN-13: 9780130226167, 2001.

2. Daniel Jurafsky and James H. Martin, SPEECH and LANGUAGE PROCESSING - An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Second Edition Prentice Hall, 2008.

4. Eric Keller, Improvements in Speech Synthesis, Published by John Wiley and Sons, Inc. New York, NY, USA, 2001.

Paper Name: Human Computer Interaction

Content

Part One: Foundations

1. The human
2. The computer
3. The interaction
4. Paradigms

Part Two: Design Process

5. Interaction design basics
6. HCI in the software process
7. Design rules
8. Implementation support
9. Evaluation techniques
10. Universal design
11. User support

Part Three: Models and Theories

12. Cognitive models
13. Socio-organizational issues and stakeholder requirements
14. Communication and collaboration models
15. Task analysis
16. Dialogue notations and design
17. Models of the system
18. Modeling rich interaction

Part Four: Outside the Box

19. Groupware
20. Ubiquitous computing and augmented realities
21. Hypertext, multimedia, and the world wide web

References:

1. Alan Dix, Janet Finlay, Gregory Abowd & Russell Beale. **Human-Computer Interaction.** 3rd Edition. Prentice Hall, 2004. ISBN 0-13-046109-1.
2. Heken Sharp, Yvonne Rogers, & Jenny Preece **Interaction Design: Beyond Human-Computer Interaction.** West Sussex, England, John Wiley & Sons, Inc, 2007. ISBN 978-0-470-01866-8; 0-470-01866-6.
3. Andrew Sears and Julie A. Jacko (Eds) **The Human-Computer Interaction Handbook.** (2nd edition) CRC Press, 2007. ISBN 0-8058-5870-9;

Paper Name: Secure Computing

Content

1. **Security Models and Assessment**
Data Versus Information,Identification and Authentication Essentials, Access Control and Access Control Structures, Security Policies Security Models and Confidentiality, Organization Security Architecture, Risk Analysis, Vulnerability Analysis, Security Audits and Risk Management, Security Assurance and Evaluation Criteria.

2. Network Security
TCP/IP Security, PPP, ECP. TLS EAP, DESE-bis, Firewall, IP Sec Architecture and Protocols, Dial in Operations, RAS PAP, CHAP, RADIUS, DIAMETER, Key distribution, IKE, Certification and Management, Intrusion Detection Systems, VLANs and VPNs, Email security, Network Attacks and DNS protection, DMZ , Proxy services.

3. **Operating System and Application Security**
PGP, Authentication, Processes, Files, Users, Buffer Overflow Attacks, Kernel Flaws, Logging, Backups, Access Control Systems using Swipe Cards, RFID, Biometrics.

4. Techniques Encryption
Cryptography Techniques, Block ciphers & Data encryption standards, Public key encryption and hash functions, Authentication applications.

5. **Security Evaluation, Practices and Incident Response**
Security Audit, Network Audit, Security Policy, Risk Mitigation, Computer Forensics

Text Books :

1. William Stallings, Cryptography and network security principles and practices, Pearson Education, Fourth Edition , 2007

2. Douglas R.Stinson, Cryptography Theory and Practice, CRC Press, Second Edition, 2005.

REFERENCES

1. Matt Bishop, Computer Security Art & Science, Pearson Education, second Indian reprint 2005.

2. Charlie Kauffman, Radia Perlman, Mike Speciner Network Security Priavte Communication in Public World, Pearson Education, 2005

3. IEEE Transactions on Information Forensics & Security (IEEE Journal ACM Transactions on Information and System Security (TISSEC), International Journal of Information Security: By Springer.

Paper Name: Trends on Software Engineering

Content

Software Engineering: A preview. Software engineering principles.

Techniques on software requirement as well as design specifications: Data Flow Diagram, Control Flow Diagram, UML, Finite State Machine, Petrinet, Logic. Software architectures for Client server, Distributed, Web services, Grid based and real time systems.

Verification: Testing – flowgraph and path testing, transaction flow testing, data flow testing, domain testing, logic based testing, graph and syntax in testing, states and transactions in testing. model checking.

Production process: process models, quality metrics, costing, risk management. Software engineering tools and environment: design tool, code generator, management tools.

References:

1. Carlo Ghezzi, Mehdi Jazayeri and Dino Mandrioli, "Fundamentals of Software Engineering", 2/E,
2. Prentice Hall, 2002
3. Ian Summerville, "Software Engineering", 8th edition, Pearson Education, 2006.
4. Grady Booch, James Rumbaugh, Ivar Jacobson, "Unified Modeling Language User Guide", Addison-Wesley Professional, 1998.
5. Shari Lawrence Pfleeger and Joanne M. Atlee, "Software Engineering: Theory and Practice", (2nd Edition), Prentice Hall, 2005
6. Open source software on software engineering tools like Eclipse, IEEE software published by IEEE computer society,2006

Paper Name: Theory Logic and Model of Computation

Content

LOGIC FOR COMPUTER SCIENCE

Propositional Logic: Propositions. States, Operators, and Truth Tables. Proofs of Equivalence with Truth Tables. Laws of Propositional Logic. Semantic Tableaux. Soundness and Completeness. Implementation.

Proof Strategies: Deductive Proofs, The Gentzen System G, The Hilbert System H, Soundness and completeness of H, Proof Checkers, Resolution, Binary decision diagrams (BDD's), Algorithms on BDD's.

Predicate Logic: Predicates and Functions. Predicates, Quantifiers. Multiple Quantifiers.

Proving with Predicates: Inference Rules with Predicates. Proof Strategies with Predicates. Mathematical Induction. Limits of Logic.

Program Verification: Definitions. Inference Rules. Loop Invariants. The Debate About formal Verification. The Z notation.

Logic Programming: The Essence of Prolog and Its Relation to Logic. Getting Started Using Prolog. Database Operations in Prolog. The General Form and Limitations of Prolog. How Prolog Works. Structures. Lists and Recursion. Built-in Predicates and Operators.

Temporal logic: Syntax and Semantics, Models ot time, Semantic Tableaux, Specification and verification of programs, Model Checking.

COMPUTING MODELS FOR COMPUTER SCIENCE

Language Models: Programming Languages and Computer Science. Ambiguity and language Design. Formal Languages. Operations on Languages. The Questions of Formal Language Theory.

Finite Automata and Their Languages: Automata: The General Idea. Diagrams and Recognition. Formal Notation for Finite Automata. Finite Automata in Prolog. Nondeterminism: The General Idea. Nondeterministic Finite Automata. Removing Nondeterminism. A-Transistions. Pattern Matching. Regular Languages.

Regular Expressions: Regular Sets. Regular Expressions

Context-Free Grammars: Limitations of Regular Languages. Introduction to Context-Free Grammars. RE Operators in CFGs. Structure, Meaning, and Ambiguity. Backus Normal form and Syntax Diagrams.

Pushdown Automata and Parsing: Visualizing PDAs. Standard Notation for PDAs. NPDAs for CFG Parsing Strategies. Deterministic Pushdown Automata and Parsing. Bottom-Up Parsing. Pushdown Automata in Prolog. Notes on Memory.

Turing Machines: Beyond Context-Free Languages. A Limitation on Deterministic Pushdown Automata. Unrestricted Grammars. The Turing Machine Model. Infinite Sets. Universal Turing Machines. Limits on Turing Machines. Undecidability. Church-Turing Thesis. Computational Complexity.

Text Books:

1. Mordechai Ben-Ari, "Mathematical Logic for computer Science (2nd edition)", Springer Publications.
2. Michael Huth and Mark Ryan, "Logic in Computer Science: Modelling and Reasoning about Systems (2nd edition)", 2004, Cambridge university Press.
3. Jean Gallier, "Logic for Computer Science: Foundations of Automated Theorem Proving", 1986, Wiley.
4. John Martin, "Introduction to Languages and the Theory of Computation", 2003, Tata McGraw Hill.
5. H.R.Lewis & C.H.Padpadimitrou, "Elements of the Theory of Computation", 2001, Pearson Education.

Paper Name: Advanced Networks

Content

Quality of Service:

1. Integrated and Differentiated Services
2. Classification, Metering, Policing, Shaping using average meter, exponential average meter, leaky bucket and token bucket meters.
3. Dropping using Drop Tail, RED, WRED etc.
4. Queuing and Scheduling using Priority Queues, Class-Based Queues (CBQ), Weighted Fair Queuing (WFQ), Round-Robin, Weighted Round-Robin (WRR), FCFS.
5. Protocols: RSVP, Diffserv, MPLS, MPLS+Diffserv.

Wireless Networks:

1. MAC Layer: Wireless LANs – 802.11 in PCF and DCF modes, Wireless WANs – 802.16.
2. Network Layer: Mobile IP (routing, handoff latency issues), MANETs (routing, address allocation, clustering), Mesh Networking
3. Transport Layer: TCP in wireless networks – issues, improvements in performance using the various flavors of TCP such as Reno, Newreno, SACK, Delack, Veno, Vegas, Jersey etc., fairness issues in TCP, especially in ad hoc networks.
4. Application Layer: Service discovery issues, QoS issues in wireless ad hoc networks.
5. Cross-layer Solutions: Fast Handoff in MIPv6 using layer 2 triggers.

Suggested Reading:

1. *QoS control in High Speed Networks* by H.Jonathan Chao, Xiaolei Guo, John Wiley & Sons, 2001.
2. *MPLS and Label-switching networks- 2nd Ed.*, Uyless Black, Pearson Education, 2002.
3. *Computer Networks*, Andrew Tanenbaum, 4th Edition, Pearson Education, 2003
4. *Internetworking with TCP/IP vol. 1*, Douglas Comer, Fourth Edition, 2001, Pearson Education.
5. *Ad hoc Wireless Networks – Architectures and Protocols*, C.Sivaramamurthy and B.Manoj, Pearson Education, 2004
6. *Mobile Ipv6: Mobility in wireless Internet*, Hesham Soliman, Pearson Education, 2004
7. Evangelos Vayias, Intracom SA, George Kormentzas, John Soldatos, "*On the Building Blocks of Quality of Service in Heterogeneous IP Networks"*, Athens Information Technology, University of the Aegean, IEEE Communication Surveys, First Quarter, Vol.7, No. 1, 2005
8. Nitin Vaidya's Tutorial on Wireless Networks, http://www.crhc.uiuc.edu/wireless/tutorials.html
9. *Ian F. Akyildiz, Xudong Wang, Weilin Wang, "Wireless Mesh Networks:A Survey*", Computer Networks 47, pp.445–487, 2005
10. Leung and Victor O.K. Li, Ka-Cheong, "*Transmission Control Protocol in Wireless Networks: Issues, Approaches and Challenges"*, IEEE Communications Surveys, 4th Quarter, Vol. 8, No. 4, 2006.
11. Bhaskar Sardar and Debashis Saha, "*A Survey of TCP Enhancements for Last-Hop Wireless Networks"*, IEEE Communications Surveys, 3rd Quarter, Vol. 8, No. 3, 2006

Paper Name: Trends in Softcomputing

Contents

Essentials of Artificial Neural Networks: Introduction, Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN – Connectivity (Feed forward, feedback, Single and Multi-layer), Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules (Error Correction, Hebbian, Competitive, Stochastic), Types of Application (Pattern Classification, Pattern Clustering, Pattern Association / Memory, Function Approximation, Prediction, Optimization)

Support Vector Machines, Boltzmann Machine, Feedback (Recurrent) Networks and Dynamical Systems

Matrix memories, Bidirectional Associative Memory, Hopfield Neural Network,

Principal Component Analysis Networks (PCA), Kohonen's Self-Organizing Maps, Linear Vector Quantization, Independent Component Analysis Networks (ICA)

Fuzzy Logic: Basic concepts, fuzzy set theory, basic operations, fuzzification, defuzzification, neurofuzzy approach, applications

Evolutionary and Genetic Algorithms: Basic concepts of evolutionary computing, genetic operators, fitness function and selection, genetic programming, other models of evolution and learning

Rough Set Theory: Basic concepts, indiscernability relation, lower and upper approximation, decision systems based on rough approximation, applications

Text Books:

1. Jacek M. Zurada. Introduction to Artificial Neural Systems, Jaico Publishers, 1992.
2. S. Haykin. Neural Networks: A Comprehensive Foundation, Prentice Hall, 1999
3. P. S. Churchland and T. J. Sejnowski. The Computational Brain. MIT Press, 1992.
4. A. M. Ibrahim. Introduction to Applied Fuzzy Electronics. PHI, 2004
5. Z. Pawlak. Rough Sets, Kluwer Academic Publishers, 1991.
6. Genetic Algorithm in Search Optimization and Machine Learning, D. E. Goldberg, Pearson Education, 1989
7. An Introduction to Genetic Algorithms, Melanie Mitchell, PHI, 1998

Paper Name: Learning & Reasoning

Content

Review Basic Tasks, Methods and underlying problems of Machine Learning. Learning methods such as role, analogical, EBG, EBL, Chunking. Learning by examples - Version space algorithm, ID3 algorithm and Decision List learning. A brief intro to ANN, Bayesian and Instance-based learning. Important systems and applications to the problem of knowledge acquisition for expert system including first-order inductive learning, FOCL, C4.5.

Survey of Representation techniques: representation schemes: Logic: Procedural representations: Semantic networks: Conceptual structures: Production systems: Analogical representation: Semantics primitives: Frames and Scripts: conceptual Dependency: Applications of Knowledge Representation.

Languages, Syntax and well-formed formulas (wffs), Semantics, Properties of Wffs. Formal deduction - Inference Rules, Logical Axioms, Formal Proofs, Theories and Theorem Proving Lowentheim-skolem Theorems, Classical first order logics-Propositional logic, Predicate Calculus. Non-classical Logics and their application to knowledge representation and processing.

Brief Introduction - Many sorted Logics, Non-monotonic Logics, Multi-valued Logics, Fuzzy Logic, Modal Logic, Temporal Logic, Intentional Logic.

Text Books:

1. R. S. Michalsky, T. Mitchell, J. Corbonell, Machine Learning, Vol I, II and III, Springer-Verlag, 1983/1990
2. T. M. Mitchell. Machine Learning, McGraw-Hill, 1997.
3. Ronald J. Brachman & Hector Levesque, Knowledge Representation & Reasoning, Morgan Kaufmann 2004

Paper Name: Natural Language Processing

Content

Introduction to Natural Language Understanding, Generation and Learning. Corpus Linguistics and Lexical Resources, Electronic Dictionaries, Morphology, Stemming and POS Tagging. Computational Grammars, Parrses, Chunking and Shallow Parsing. Semantics and Pragmatics. Word Sense Disambiguation and Anaphora Resolution. Applications to Information retrieval, Information Extraction, Automatic Text Summarization, Automatic Text Categorization and Machine Translation. ISCII, Unicode and Indian Language Processing.

Text Books:

1. Kavi Narayana Murthy, "Natural Language Processing: An Information Access Perspective", Ess Ess Publications, New Delhi, 2006

2. Christopher D Manning and Hinrich Schutze, "Foundations of Statistical Natural Language Processing" The MIT Press, 2000

Paper Name: Metaheuristic Techniques

Content

Introduction to Local Search, Heuristics and Metaheuristics.

Genetic Algorithms: Basic Concepts, Simple Genetic algorithm, Real-Coded Genetic Algorithm, Permutation-Coded Genetic Algorithm, Grouping Genetic Algorithm, Multiobjective Genetic Algorithm, Estimation of Distribution Algorithms (EDAs)

Swarm Intelligence Based Methods: Basic concepts, Ant-Colony Optimization, Artificial Bee Colony Algorithm, Particle Swarm Optimization

Tabu Search: Basic Concepts- Tabu Tenure, Cycle Detection & Aspiration Criterion, Reactive Tabu Search.

Elementary idea about Variable Neighborhood Search, Differential Evolution, and Evolutionary Programming.

Suggested Readings and Links:

1. Genetic Algorithm in Search Optimization and Machine Learning, D. E. Goldberg, Pearson Education, 1989.

2. An Introduction to Genetic Algorithms, Melanie Mitchell, PHI,1998.

3. Ant-Colony Optimization, M. Dorigo and T Stutzle, PHI, 2004.

4. Tabu Search, F. Glover, M. Laguna, Kluwer Academic Publisher, 1997

5. http://www2.lut.fi/~jlampine/debiblio.htm (Differential Evolution Bibliography)

6. http://mf.erciyes.edu.tr/abc/links.htm (Artificial Bee Colony Algorithm Homepage)

7. A Tutorial on Variable Neighborhood Search available from http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.4.2350

8. A Review of Particle Swarm Optimization: Part I and Part 2, Alec Banks, J. Vincent, C Anyakhon (dx.doi.org/10.1007/s11047-007-9049-5, dx.doi.org/10.1007/s11047-007-9050-z)

Paper Name: Mobile Computing

Content

Cellular architecture, Mobile Computing issues and challenges, Architecture issues, communication issues, bandwidth management issues, energy issues, information management issues, Reliability issues, security issues, Social issues, Trust management and anonymity issues, Applications (horizontal and vertical), Wireless Mobile Network Characteristics, portable characteristics, mobility characteristics.

Wireless Communication principles: Multiplexing (SDM, FDM, TDM, CDM) , Modulation, Hidden terminal, Exposed Terminal

Channel allocation: Fixed Channel Allocation, Dynamic Channel Allocation, Hybrid Channel Allocation, Flexible Channel Allocation

Location Management: Location Management Problem, Location management Update principles (No-Update, Full-Update, Lazy-Update, Selective-Update), Location management Architecture (two tier, Tree-based, hierarchical etc.), Location Management Algorithms (Two location, Reporting Cell, Profile-based, etc)

Mobility Model: Individual mobility model (Random walk, Random way-point, random-direction, smooth random, Gauss-Markov model), Group-based mobility model (Column, Nomadic, Pursue, Reference Point Group-Mobility model)

Mobile Protocols: Mobile-IPv.4, Ipv.6, Mobile TCP (m-TCP)

Information Dissemination: Information dissemination through wireless medium, broadcasting, Push, Pull, Periodic, on-demand, real-time, variable-sized data broadcasting schemes

Mobile Payment Models: Payments in Mobile environment, e-cash, M-pay, Pay-box, EMPS, e-ticket

Mobile Computing application development using J2ME platform.

Sensor Network : Wireless Sensor Network, WSN Applications, Sensor Network Issues and challenges, Energy management in WSN, Sensor Network Routing Protocols (Data Aggregation, Clustering, Data Fusion)

Books and References: (This list is only indicative not exhaustive)

1. Mobile Communications by Jochen Schiller, Pearson Publications
2. Mobile Computing (ed.) by Tomasz Imielinski & Henry F. Korth, Kluwer Academic Publishers
3. Mobile Computing – Technology, Application & Service Creation, Asoke Talukder, Roopa Yavagal, McGraw Hill Publications
4. Mobile Computing Hand Book by Mohammad Ilyas, Auerbuch Publications
5. Mobile Commerce (ed.) by Hrushikesha Mohanty & Ratan Ghosh, Allied Publishers
6. Wireless Sensor Networks (ed.) by C. S. Raghavendra, Krishna M. Sivalingam, Taieb F. Znati, Springer Publications, 2004
7. Tolga Onel, Ertan Onur, Cem Ersoy and Hakan Delic, "Wireless Sensor Networks for Security:Issues and Challenges" , Book Chapter, Advances in Sensing with Security Applications, Springer Publications, 2006

Some Research Papers

1. George H Forman, J Zahorjan, " The Challenges of Mobile Computing", IEEE Computers, Vol. 27(4), 1994, pp 38-47
2. I Katzela & M. Naghshinesh, "Channel Assignment Schemes for cellular mobile telecommunication systems", Personal Communications Magazine, June, 1996.
3. Tomasz Imielinski, B. R. Badrinath"Mobile Wireless Computing: solutions and Challenges in Data Management", Communications ACM, Vol. 37(10), pp. 18-28 (1994)
4. F. L. Lewis, "Wireless Sensor Networks", Smart Environments: Technologies, Protocols, and Applications (ed.), by D.J. Cook and S.K. Das, John Wiley, New York, 2004.

Paper Name: Datamining

Content

Introduction to Data mining and Data Pre-processing:

Why Data mining, What is data mining, Data mining: On what kind of data, Data mining functionality, Are all the patterns interesting, Classification of data mining systems, Major issues in Data mining.

Mining Association Rules:

Boolean Associate rule, Quantitative Association rule, Single dimensional association rule, Multi-Dimensional association rule, Single or Multi-level association rule, *Apriori Alogorithm, Frequent Pattern Tree (FTP) algorithm*.

Classification Algorithms:

Classification by decision tree induction (ID3), Bayesian Classification, Classification by Neural Networks, Classification by Support Vector Machines (SVM), Other classification methods, Prediction, Classification Accuracy

Clustering Algorithms:

What is cluster analysis, Types of data in Cluster analysis, Categorization of Major clustering methods, partitioning methods (K-means and K-medoids), Hierarchical Methods, Density-Based methods, Outlier Analysis.

Time Series and Sequence data mining:

What is time series and sequence data mining, Mining time series, Mining time series and sequence data, estimation of trend curve, discovery of trend in time series, similarity search in time series analysis, Sequential Pattern mining, Research issues in Sequential Pattern mining, Research issues in Time sequence mining.

Graph Mining, Text Mining, Web mining, Spatial Mining, Temporal Mining

References

(1) J. Han and M. Kamber. Data Mining: Concepts and Techniques. Morgan Kaufmann, 2001, Elsevier 2006
(2) D. J. Hand, H. Mannila, and P. Smyth, Principles of Data Mining, MIT Press, 2001, Prentice hall India-2005
(3) Pang-Ning Tan, Michael Steinbach and Vipin Kumar, Introduction to datamining, Addison Wesley, 2005
(4) U. Fayyad, G. Grinstein, and A. Wierse, Information Visualization in Data Mining and Knowledge Discovery, Morgan Kaufmann, 2001
(5) G. Piatetsky-Shapiro and W. J. Frawley. Knowledge Discovery in Databases. AAAI/MIT Press, 1991
(6) S. M. Weiss and N. Indurkhya, Predictive Data Mining, Morgan Kaufmann,1998

Paper Name: Bioinformatics

Content

Bioinformatics deals with the science of storing, extracting, organizing, analyzing, and interpreting biological data. The course is designed for computer scientists who want an introduction to the language of molecular biology and the significant computational problems in the field of biology. Its importance has increased with the technology of DNA sequencing, microarrays, as well as the widespread understanding that genes and proteins act in networks. The goal of this course is to introduce the main topics in bioinformatics and the focus is on algorithm development for solving computational problems in biology.

Course Outline

1. Basics of Molecular Biology
2. Database Archives and Information Retrieval
3. Homology Modeling : Alignment Algorithms of Pairs of Sequences
4. Multiple Sequence Alignment
5. Introduction to Probability and Statistical Analysis of Sequence Algorithms
6. Database Searching for Similar Sequences
7. Phylogenetic Prediction
8. Protein Classification & Structure Prediction
9. Genome Analysis
10. Gene Prediction
11. Analysis of Microarrays

References:

1. David W Mount, Bioinformatics : Sequence & Genome Analysis, Cold Spring Harbor, 2000.
2. Arthur Lesk, Introduction to Bioinformatics, Oxford Univ Press, 2002.
3. Neil C Jones Pavel A Pevznner, An Introduction to Bioinformatics Algorithms, OUP, 2007.

APPENDIX I:

Course Numbers

Numbering scheme: Following are guidelines for the numbering scheme being adopted for PhD courses.

- Courses for the PhD are distinguished by 800-series. The 2-letter suffix will indicate the stream (CS, AI, and IT) that they belong to.
- Course Numbering Scheme for PhD Programme: 800-809: Core (Required); 810-899: CS/AI/IT stream Electives

Core Courses: (Mandatory)
CS801 Data Structure and Algorithms
CS802 Operating System and Programming

Elective Courses:
CS810 Advanced Networking
CS811 High Performance Computing

CS820 Theory Logic and Model of Computation
CS821 Trends in Software Engineering

IT810 Mobile Computing
IT811 Secure Computing

AI810 Metaheuristic Techniques

AI820 Digital Image Processing
AI821 Pattern Recognition

AI831 Spoken Language Processing
AI832 Natural Language Processing
AI833 Human Computer Interaction

AI840 Bioinformatics

AI851 Trends in Softcomputing
AI852 Learning & Reasoning
AI853 Datamining