

Related Courses

CS711 Research Methods for Computer Science (3 cr.hrs)

Objectives

This course includes an understanding of:

- What CS researchers do, and the philosophy and ethics related to how they do it.
- Proficiency at communications, especially technical writing.
- Proficiency at designing experiments for the purpose of testing research hypotheses, and evaluating the results of those experiments.

After finishing this course a student should know how research is done at M.S. and Ph.D. levels?
A student should know how quantitative and qualitative research should be done?

Contents

Introduction

- What should CS graduate students know about the research methodology?
- The objectives and dimensions of research
- Why Research, What is research, How is research done
- Tools of research, Library, The internet, Measurements for Computer Science research, Statistics, Data analysis tools

Critiques of paper reviews

Research Methods:

- The research problems
- Finding a problem, stating the problem, identifying sub-problems
- Review of related literature
- Why review the literature, Including literature in research proposal
- Survey paper presentation
- Empirical Methods of Algorithm Analysis
- Analytic vs. empirical; deterministic and stochastic algorithms

Working with human subjects:

Qualitative studies, Quantitative studies, Interview techniques

Paper Writing, Reviewing Publishing

Starting on Research

- What constitutes a PhD thesis?
 - Expectations of publication
- Role of the thesis supervisor
- Finding a good problem, top-down approach
 - New problem needing tools
 - Tools looking for a problem

- Looking at future trends
 - Impact
 - Scalable: simplify using assumptions?
 - You know of a starting point
 - Online tools
 - Google, CiteSeer, ACM Digital Library, IEEE
 - Survey papers, people
- Grants and Research proposals
- Intellectual property

Recommended Readings

1. Fabb, How to write essays, dissertation, and thesis in literary studies, Publisher: Longman, Copyright: 1993
2. [James E. Mauch](#), [Jack W. Birch](#)., Guide to the Successful Thesis and Dissertation, Publisher: Marcel Dekker, copy right 2003
3. Leedy, P. L., Practical Research, Planning and Design, Publisher: Prentice Hall, March 2004

CS712 Statistical Analysis

(3 cr.hrs)

Objectives

The subject of statistics is very important in many areas including computer science. The main objective of this course is that a student should know the basics of statistics and he/she should be able to do statistical analysis independently in his/her research work.

Contents

Basic Univariate Statistical Methods:

Review of basic concepts, summary measures, introduction to hypothesis testing, t-test for one and two samples, Analysis of Variance (ANOVA), Chi-squared test for count data, Regression and Correlation

Multivariate Statistical Methods:

Introduction to Multivariate Analysis, Principal Component Analysis (PCA), Factor Analysis (FA), Discriminant Analysis (DA), Cluster Analysis (CA), Multidimensional Scaling (MDS).

Special topics (with applications in Corpus Linguistics):

Hidden Markov Models (HMM), Log-linear models, Bayesian Statistics

All the techniques would be learned through a computer-integrated approach. The analysis would be carried out by using SPSS and/or Minitab (or any other special-purpose statistical software).

Recommended Readings

1. Oakes, M.P. (1998, 2005). Statistics for Corpus Linguistics. Edinburgh Textbooks in Empirical Linguistics. Edinburgh University Press, Edinburgh.
2. Walpole, R.E. (1982). Introduction to Statistics. 3rd Edition, Macmillan Publishing Co. Inc., New York.
3. Johnson, R.A., Wichern, D.W. (2002). Applied Multivariate Statistical Analysis. 5th Edition, Prentice Hall, New Jersey.

CS713 Introduction to Mathematical Logic

(3 cr.hrs)

Objectives

The main objective of this course includes the basic study of mathematical logic. It helps a lot in understanding several concepts in computer science.

Contents

Introduction, Propositional Calculus, Methods of Proof, Analysis of Arguments, Predicate Calculus and Quantifiers, Boolean Algebra to Logic, Boolean Functions, Boolean Algebra and Propositional Logic, Logic Gates, Combinational Circuits.

Recommended Readings

1. Irving M.Copi, Symbolic Logic, Collier MacMillan Publishers, 1973
2. Patric J. Hurley, A Concise Introduction to Logic, Ward Worth Publishing Company, 1991.
3. Elliott Mendelson, Boolean Algebra and Switching Circuits, McGraw Hill Book Company, 1970.

Major Courses (MS)

CS731 Theory of Computation

(3 cr.hrs)

Objectives

After the completion of this course a student will be able to have a clear understanding of:

- The processing mechanism of a computer system at abstract level
- What a computer can do and what it cannot do?
- What a computer can do more efficiently and what it can perform with less efficiency?
- The mechanism of different word processors (especially spell-checking facilities)
- The mechanism of different grammar checkers
- The mechanism of word generators

- How to develop more efficient spell-checkers and parsers?

Description

Automata theory, formal languages, Turing machines, computability theory and reducibility, computational complexity, determinism, non-determinism, time hierarchy, space hierarchy, NP completeness, selected advanced topics.

Recommended Readings

1. Michael Sipser, Introduction to the Theory of Computation, First Edition, 1997, PWS publishing Company.
2. Christos Papadimitriou, Computational Complexity, 1994, Addison-Wesley.
3. John Hopcroft and Jeffrey Ullman, Introduction to Automata Theory, Languages, and computation, 1979, Addison- Wesley. (or the second edition).
4. Tao Jiang, Ming Li, and Bala, Ravikumar, Formal Modals and Computability, in Handbook of computer science, CRC Press, 1996.
5. T.H. Cormen, et al., Introduction to Algorithms, MIT Press and McGraw-Hill Book Co, 1990.
6. Peter Linz , An introduction to Formal Language and Automata, ISBN: 0-669-17342-8.

CS732 Advanced Algorithm Analysis

(3 cr.hrs)

Objectives

For any and every complex program, the actual programming hardly takes 20% of the time. The bulk of the time is spent in coming up with the logic including how to solve the problem, how good or bad the solution is etc. This is dependent on many factors such as the type of solution used, the methodology of storing data etc, which in turn is dependent on the solution space, i.e. possible number of solutions etc.

To develop an understanding of the concepts and complexities of algorithms, so the students can appreciate the requirement of fast and efficient algorithms. Cover different sorting and graph algorithms, along with the concept of theory of NP completeness, so that students can identify computationally intractable problems. Touch upon some advanced topics such as Genetic Programming, Visualization etc.

The main focus will be looking at the algorithms from an applied perspective, this includes coding algorithms using efficient data structures, running simulations and comparing results.

Course Description

Advanced analysis including the introduction of formal techniques and the underlying mathematical theory. NP- Completeness. Search techniques. Randomized Algorithms. Heuristic and Approximating Algorithms. Topics include asymptotic analysis of upper and average complexity bound using big-O, little-O and theta notation, Fundamental algorithmic strategies (brute-force, greedy, divide-and-approximations) are covered. Also include are standard graph

and tree algorithms. Additional topics include standard complexity classes, time and space tradeoffs in algorithms, using recurrence relations to analyze recursive algorithms, non-computability functions, the halting problem, and the implications of non-computability. Algorithmic animation is used to reinforce theoretical results. Upon completion of the course, students should be able to explain the mathematical concepts used in describing the complexity of an algorithm, and select and apply algorithms appropriate to a particular situation.

Recommended Readings

1. T. Cormen, C. Leiserson, and R. Rivest. Introduction to Algorithms, Second Edition. MIT Press and McGraw-Hill, 2001.
2. Robert Sedgwick: Algorithms, 2nd Edition Addison-Wesley 1988
3. An Introduction to the Analysis of Algorithms by Sedgwick and P. Flajolet. Addison Wesley. 1996
4. Alfred V. Aho, Jeffrey D. Ullman, Data Structures and Algorithms, Addison Wesley. 1983
5. David Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Pearson Education, Inc. 1989.
6. M. Garey and D. Johnson. Computers and Intractability: A Guide to the Theory of NP-Completeness. W.H. Freeman and Company, New York, NY, 1979.
7. Tao Jiang, Ming Li, and Bala Ravikumar, Formal models and Computability, in Handbook of Computer Science, CRC Press, 1996.
8. T.H. Cormen, et al., Introduction to Algorithms, MIT Press and McGraw-Hill Book Company, 1990.

CS 733 Advanced Operating Systems

(3 cr.hrs)

Objectives

- To provide in-depth coverage of modern operating system issues.
- To provide insight in the design principles of distributed systems.
- To focus on a high level functionality of operating systems, such as, file systems, security, and naming mechanisms.
- To provide experience in reading and evaluating research papers.

Description

The class covers advanced topics in computer operating systems with a special emphasis on distributed computing, and the services provided by distributed operating systems. Important topics include naming, security, remote procedure call, networks, concurrency, transactions, parallel computing, shared memory, message passing and scale.

Recommended Readings

1. Coulouris, Dollimore, and Kingberg , “Distributed Systems: Concept and Design” , 3rd Edition, 2005.

CS734 Advanced Computer Architecture

(3 cr.hrs)

Objectives

- To investigate computer architecture with a particular focus on microprocessor design.
- To explore current trends and future directions in processor micro architecture.
- To explore various hardware and software techniques designed to maximize parallelism and improve performance keeping in mind technology trends and limitations.
- The foci of the course will be both current practice and advanced research.

Course Description

Design and evaluation of modern uni-processor computing systems. Evaluation methodology / metrics and caveats, instruction set design, advanced pipelining, instruction level parallelism, prediction-based techniques, alternative architecture (VLIW, Vector and SIMD), memory hierarchy design and I/O. Case studies.

Recommended Readings

1. John L. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach, 3rd Edition, Morgan Kaufmann Publishers,2002.
2. Andrew S. Tanenbaum, Modern Operating Systems, 2nd Edition, Prentice Hall, 2001.
3. John Hennessy and David Patterson, Computer Organization and Design: The Hardware/ Software Interface, 2nd Edition, Morgan Kaufman Publishers, 2004.

CS735 Middleware-I

(3 cr.hrs)

Objectives

- Understand the role and importance of middleware to integrating multiple applications.
- Articulate the key problems addressed by middleware
- Describe the Architecture of a middleware Solution
- Understand the role of connectivity data transformation and business rules processing in middleware Solution.
- Understand loosely coupled systems Publish- Subscribe architecture

Course Outline

This course introduces students to the need for communication between and among application, that middleware is itself application and how middleware applications are typically organized

Course Contents

- Middleware concept, Roles and organization
 - Introduction to Middleware.
 - Background
- Management of integration
- Data transformation, Data Synchronization
- Business process modeling
- Service oriented architecture
- Web Services / B2B

Recommended Readings

1. Judith M. Meyerson, “The Complete Book of Middleware”, 2002
2. Latest online available resources

CS736 Advanced Databases

(3 cr.hrs)

Objectives

The objective of this course is that a student should learn the advanced level technology information in databases. A student should know different database connections available for different programming languages and learn how data is converted from a database management system to other formats and vice versa. A student should study recent research work in database technology.

Contents

Review of relational databases SQL in the real world: embedded SQL, data passing, status, cursor, connection, transaction, stored procedure; dynamic SQL, parameter, descriptor; JDBC; SQLJ; ODBC. Relational calculus; DB services XML databases, description and query of semi-structured, nested, complex data; XML basics, XML schema, XLST. Stylesheet, templates, evaluation. XQuery: FLWR expression, evaluation, built-in functions, user defined functions, aggregation, quantification. More XQuery: data and types; Xquery and XML schema; proj, sel, construction, group, join, recursive functions, wildcard types, XqueryX; XPath and XQuery, Materialized views.

Recommended Readings

1. Database and transaction processing: An Application-Oriented Approach by Philip M. Lewis, Arthur Bernstein and Michael Kifer. Addison Wesley, 2002.

CS737 Data Warehousing

(3 cr.hrs)

Objectives

The objective of this course is that a student should learn the fundamentals of data warehousing. A student should know what state-of-the-art techniques are available and how dimensional modeling is performed in data warehousing? A student should learn the design process of a data warehouse after finishing this course. The study of recent research papers is another primary objective of this course.

Contents

- Introduction to Data Warehousing: Heterogeneous information; the integration problem; the Warehouse Architecture; Data Warehousing; Warehouse DBMS.
- Aggregations: SQL and aggregations; aggregation functions; grouping.
- Data Warehouse Models and OLAP Operations: Decision support; Data Marts; OLAP vs OLTP; the Multi-Dimensional data model; Dimensional Modelling; ROLAP vs MOLAP; Star and snowflake schemas; the MOLAP cube; roll-up, slicing, and pivoting.
- Some Issues in Data Warehouse Design: monitoring; wrappers; integration; data cleaning; data loading; materialised views; warehouse maintenance; OLAP servers; metadata.

Recommended Readings

1. M. Jarke, M. Lenzerini, Y. Vassiliou, P. Vassiliadis (ed.), Fundamentals of Data Warehouses, Springer-Verlag, 1999.
2. Ralph Kimball, The Data Warehouse Toolkit, Wiley 1996.

CS738 Data Mining

(3 cr.hrs)

Objectives

With the unprecedented rate at which data is being collected today in almost all fields of human endeavor, there is an emerging economic and scientific need to extract useful information from it. Data mining is the process of automatic discovery of patterns, changes, associations and anomalies in massive databases. This course will provide an introduction to the main topics in data mining and knowledge discovery, with a special emphasis on Data mining & Web mining

Contents

Introducing Data Mining: Why data mining?; What is data mining?; A View of the KDD Process; Problems and Techniques; Data Mining Applications; Prospects for the Technology.

The CRISP-DM Methodology: Approach; Objectives; Documents; Structure; Binding to Contexts; Phases, Task, Outputs.

Data Mining Inputs and Outputs: Concepts, Instances, Attributes; Kinds of Learning; Providing Examples; Kinds of Attributes; Preparing Inputs. Knowledge Representations; Decision Tables and Decision Trees; Classification Rules; Association Rules; Regression Trees and Model Trees; Instance-Level Representations.

Data Mining Algorithms: One-R; Naïve Bayes Classifier; Decision Trees; Decision Rules; Association Rules; Regression; K-Nearest Neighbour Classifiers.

Evaluating Data Mining Results: Issues in Evaluation; Training and Testing Principles; Error Measures, Holdout, Cross Validation; Comparing Algorithms; Taking Costs into Account; Trade-Offs in the Confusion Matrix

Recommended Readings

1. Witten and E. Frank, Data Mining: Practical Machine Learning Tools and Techniques with Java Implementations, Morgan Kaufman, 1999.
2. J. Han and M. Kamber, Data Mining: Concepts and Techniques, Morgan Kaufman, 2000.
3. D. Hand, H. Mannila and P. Smyth. Principles of Data Mining, MIT Press, 2001.
4. M. H. Dunham. Data Mining: Introductory and Advanced Topic. Prentice Hall, 2003.

CS739 Database Security

(3 cr.hrs)

Objectives

The objective of this course is that a student should learn the state-of-the-art in database security. Different database security models and data access control mechanisms are taught in this course. A student should practically implement different database security techniques using a database management software. The study of recent research papers in database security is another objective of this course.

Contents

Data protection: basic concepts.

- Access control policies: discretionary access control policies; mandatory access control policies; role-based access control (RBAC); Chinese wall access control policies.
- Administration policies - Access control in relational database systems: Grant and Revoke statements; grant operation and delegation; revoke operations recursive revocation with timestamps and without timestamps; non-cascading revoke operations; views and content-based authorization; RBAC.
- Advanced access control models: temporal authorization models; temporal RBAC; the BFA model for workflow systems; access control and integrity for XML data; the Author-X system; XACML and SAML; access control for web services.
- Trust negotiation systems: preliminary concepts; TrustBuilder; Trust-X.

Recommended Readings

1. [Hassan A. Afyouni](#), Database Security and Auditing: Protecting Data Integrity and Accessibility, Publisher: Course Technology 2005
2. Silvana Castano, Database Security, Publisher [Addison-Wesley](#) 1995
3. B. Fernandez, Rita C. Summers, Christopher Wood, Database Security and Integrity, Publisher: Addison-Wesley Longman Publishing Co, Inc. 1881

CS740 Distributed System Components

(3 cr.hrs)

Objectives

- Present the principles underlying the functioning of distributed systems;
- Create an awareness of the major technical challenges in distributed systems design and implementation;
- Expose students to modern and classic technology used in distributed systems and their software;
- Expose students to past and current research issues in the field of distributed systems;

Contents

Components of a distributed systems, Distributed systems, End to End Protocols and Networking. Distributed Operating system, Distributed databases, Communication Mechanism, Message Passing, Stream oriented communications, Remote procedure call, Remote Method Invocation, DCE RPC, Java RMI, SOAP, Naming, Clock Synchronization, Process Synchronization, Distributed Processes, Code Migration
Content distribution, Distributed Object systems, CORBA, DCOM - .NET, Distributed Coordination, Fault Tolerance, Distributed Systems Security

Recommended Readings

1. Andrew S. Tanenbaum, Maarten van Steen, “Distributed Systems Principles and paradigm”, 2nd Edition, 2006.
2. George F. Coulouris, Jean Dollimore, Tim Kindberg, “Distributed Systems: Concepts and Design”, 4th Edition, 2005.
3. Research papers based.

CS741 Advanced Networking

(3 cr.hrs)

Objectives

Aim of the course is to understand the principles of networking and the protocols in the different layers, and their interactivity between each other. Students should understand the problem in the

current Internet architecture new study new QoS architectures such as Integrated services and Differential services. Also students should know the problem with the IPv4 and need for IPv6 protocols.

Additionally students will be expected to read all of the papers assigned for the course others may be added based on class interest. Students will have to write of papers provide during the class. Students submitting reviews for a paper will be expected to be active in the discussion of that paper.

Course Description

Review of basic concepts: The OSI Model, packet and circuit switching, network topology, ISDN,. The TCP/IP protocol stack: IP, ARP, TCP and UDP, DNS, ICMP, Internet Addressing, Routing, IP multicast, RSVP, Differential Services. Next generation IP-ipng, Wireless: Radio basics, satellite systems, WAP, current trends, Issues with wireless over TCP. Congestion control: control vs. Avoidance.

Algorithms, congestion in Internet. Mobile IP, Voice over IP (VoIP), VPNs Network Security. Management: Quality of Service (QoS). Network vs. Distributed Systems management protocols, web based management. OPNET.

Recommended Readings

1. James F. Kurose and Keith W. Ross, "Computer Networking- A top-Down Approach Featuring the Internet", Addison Wesley. January 2004
2. Coulouris, Dollimore, Kindberg, "Distributed Systems- Concepts and Design", Addison Wesley. 4th edition May 20, 2005
3. William Stallings, Data and Computer Communication, Prentice-Hall- Seventh Edition 2004 (for those who wants to review the basics of networking.)

CS742 Network Security

(3 cr.hrs)

Objectives

- Understand the design and implementation of advanced cryptographic algorithms for wired and wireless computing environments including the design and implementation of RSA and ECC
- Achieve sound knowledge of network security components including the design, implementation, and configuration of Firewalls, Intrusion Detection Systems (static and dynamic checking of programs, anomaly detection, large-scale (Internet-wide) distributed intrusion detection, early sensing, complex attack scenario analysis, and automated response), Prevention Systems, Firewalls, IDSs, VPNs and prevention systems together
- Develop knowledge of advanced network security architectures to allow better network protection, load balancing and recovery from attacks

- Achieve sound knowledge of wireless network security
- Understand security in trusted-based computing environments
- Understand Quantum cryptography

Students will be expected to read all of the papers assigned from the course [reading list](#) others may be added based on class interest. Students will have to write at least two [reviews](#) of papers on the reading list. These will be submitted at the beginning of class. Students submitting reviews for a paper will be expected to be active in the discussion of that paper.

Course Description

Introduction: Cryptology and simple cryptosystems; Conventional encryption techniques; stream and block ciphers; DES; More on block Ciphers; The Advance Encryption Standard. Confidentiality & Message Authentication: Hash functions; Number theory and algorithm complexity; Public Key Encryption. RSA and discrete Logarithms; Elliptic Curves; Digital Signatures. Key management Schemes; Identification Schemes; Dial-up Security. Email Security, PGP,S-MIME; Kerberos and directory Authentication. Emerging Internet security standards; SET; SSL and IPsec; VPNs; Firewalls; Viruses; Miscellaneous topics.

Recommended Readings

1. W. Stallings, *Cryptography and Network Security*, Prentice Hall PTR, Upper Saddle River NJ, 2003.
2. C.Kaufman, R. Perlman, M.Speciner, *Network Security: Private Communication in a public World* – Prentice Hall PTR, Upper Saddle River, NJ, 2002.
3. M.Bishop, *Computer Security: Art and Science*- Addison-Wesley, 2003.
4. D.Stinson, *Cryptography: Theory and Practice*, CRC Press, Boca Raton, FL, 1995.
5. Richard A. Mollin, *An Introduction to Cryptography*, Chapman and Hall/CRC, 2001.
6. B.Schneier, *Applied Cryptography*, John Wiley and Sons, NY, 1996.
7. A.Menezes, P. Oorschot, and S. Vanstone, *Handbook of Applied Cryptography*, CRC Press, Boca Raton, FL, 1997.

CS743 Computer Networking-I

(3 cr.hrs)

Objectives

This course will cover the principles of networking with a focus on algorithms, protocols, and implementations for advanced networking services. We will begin with a brief retrospection on the design of the Internet, its basic mechanisms and protocols. We will examine a variety of ideas that were proposed to enhance the Internet, why some of these enhancements were successful while others were not. Subsequently we will move on to a select set of advanced topics in networking, primarily at recent and ongoing advances in "the edges" of the Internet.

All topics in this course will be covered through research papers. In each class I will lead a discussion on one or two papers. In order to have a discussion, students will be expected to have read these papers prior to class.

Each student in the class will be expected to do a research project. However, students are encouraged to define their own ideas for research projects. For each research project, a student should submit a written project plan, a summary at the end of the semester and an oral presentation on the project.

Course Description

This course offers an advance introduction and research perspective in the areas of switch/router architectures, scheduling for best effort and guaranteed services, QoS mechanisms and architectures, web protocols and applications, network interface design, optical networking, and network economics. The course also includes a research project in computer networking involving literature survey, critical analysis, and finally, an original and novel research contribution. Typical topics can be listed below:

Overview of packet switching networks and devices, fundamentals of Internet Protocol (IP) and networking. Route lookup algorithms. Router architecture and performance. Detailed Operation of Internet routing protocols such as Open Shortest Path First (OSPF) and Border Gateway Protocol (BGP), Integrated and differentiated networks service models. Traffic Engineering. (TE) concepts and mechanisms including label assignments, label distribution, and constraints-based routing algorithms. Multi-protocol label switching and its generalization. Quality of Service mechanisms for multimedia and real-time communications. TE-based routing and signaling protocols. Fundamentals of per-flow and aggregate scheduling algorithms. Application-level and network-level signaling protocols for data, voice and video communications. Resource signaling and resource reservation protocols. Worst-case Analysis for multimedia networking.

Recommended Readings

1. Puzmanov, *Switching and Routing*, Addison Wesley, 2002.
2. Garica and Widjaja, *Communication Networks: Fundamentals Concepts and Key Architecture*, McGram-Hill, 2001.
3. Peerson and Davis, *Computer Networking a Systems Approach*, 3rd Edition, Morgan Kaufman, 2003.
4. William Stallings, *High Speed Networks: TCP/IP and ATM design Principles*, Prentice Hall; 1998, ISBN: 0315259657. Andrew S. Tanenbaum, *Computer Networks*, 4th Edition. Prentice Hall, March 2000.

CS744 Wireless Networks
(3 cr.hrs)

Objectives

- To introduce history of wireless Networks, application domains, platforms, and the limitations of current platforms.
- To cover fundamental techniques in design and operation of first, and third generation wireless networks: cellular systems, medium access techniques, radio propagation models, error control techniques, handoff, power control, common air protocol (AMPS, IS-95, IS-136, GSM, GPRS, EDGE, WCDMA, CDMA 2000 etc),
- To explore Wireless LANs Standards, wireless LANs, Wi-Fi, WiMAX, Bluetooth, sensor networks,
- To read a large number of research papers, writing critiques, class presentations.

Course Description

This course covers fundamental techniques in design and operation of first, and third generation wireless networks: cellular systems, medium access techniques, radio propagation models, error control techniques, handoff, power control, common air protocol (AMPS, IS-95, IS-136, GSM, GPRS, EDGE, WCDMA, CDMA 2000 etc), Wireless LANs Standards, wireless LANs, Wi-Fi, WiMAX, Bluetooth, sensor networks, physical layer specifications in wireless LANs, radio resource and network management. As an example for third generation interfaces, WCDMA is discussed in detail since is intended for graduate students who have some background on computer networks.

Recommended Readings

1. W. Stallings, "Wireless Communication Networks", Prentice Hall, 2002.
2. T.S. Rappaport, "Wireless Communication: Principles and Practice", Second Edition, Prentice Hall, 2002.
3. J.Schiller, "Mobile Communications", Addison Wesley, 2000.
4. V.K. Garg, "IS-95 CDMA and CDMA2000", Prentice Hall PTR, 2000.
5. J.P. Castro, "The UMTS Networks and Radio Access Technology- Air Interface Technioques for future Mobile Systems", Wiley, 2001.
6. H. Holma and A. Toskala, "WSDMA for UMTS radio Access for third generation Mobile Communications", John Wiley & Sons, 2001.

CS745 Network Performance Evaluation

(3 cr.hrs)

Objectives

In this course students will study Analytical, simulation and experimental methods to evaluate and design networks. Will also use and Investigate network management tools and techniques such as OPNET and NS-2.

Course Description

This is an advance course in networks and protocols. Analytical, simulation and experimental methods should be used to evaluate and design networks and protocols. Investigate network management tools and techniques. OPNET, NS, and REAL.

Recommended Readings

1. T.G. Robertazzi, Computer Networks and Systems: Queuing Theory and Performance Evaluation, Springer-verlag, 2ndEdition, 1994.

CS746 Semantic Web

(3 cr.hrs)

Course Description

As the volume of Web resources grows exponentially, researchers from industry, government, and academia are now exploring the possibility of creating a Semantic Web in which meaning is made explicit, allowing machines to process and integrate Web resources intelligently. How will this Web of the future be effectively built? This course attempts to address this problem by covering most of the proposed approaches. This course provides a succinct account of this new Web, its principles, concepts, and related tools. Its main contribution lies in the ability to demonstrate how Semantic Web technologies may be integrated and realized in several application domains.

Course Objectives

According to the general objective, students should be able:

- To understand the limitations of the present web and the importance of metadata in solving the problem
- To identify and resolve real world problems by applying these technologies successfully
- To build systems in different domains (for instance, knowledge management, biomedicine, e-commerce, e-learning, etc.) and applications for those areas
- To integrate applications developed with semantic web technologies with other software and hardware systems
- To assimilate technological changes

Course Contents

Semantic Web introduction, vision and Layer Cake, Web Documents and XML, Resource Description Framework, RDF Schema and RDF Simple Entailment, SPARQL, Ontologies, Web Ontology Language OWL, Topic Maps, Logic and Inference Rules, RuleML, SWRL, Relations between Semantic Web Languages, Semantic Web Vocabularies and Applications, Web Services and Semantic Web Services, Agents on the Web, Semantic Web Applications, Ontology Engineering.

Recommended Readings

1. Grigoris Antoniou and Frank van Harmelen, A Semantic Web Primer, MIT Press, 2004.

2. Dieter Fensel, James A. Hendler, Henry Lieberman, and Wolfgang Wahlster, Spinning the Semantic Web - Bringing the World Wide Web to Its Full Potential, MIT Press, 2002.
3. Breitman, K.K., Casanova, M.A., Truszkowski, W., Semantic Web: Concepts, Technologies and Applications. NASA Monographs in Systems and Software Engineering Series, Springer 2007.

CS747 Information Architecture

(3 cr.hrs)

Course Description

The post-Ajaxian Web 2.0 world of wikis, folksonomies, and mashups makes well-planned information architecture even more essential. How to present large volumes of information to people who need to find what they're looking for quickly? This course will enable information architects, designers, and web site developers to build large-scale and maintainable web sites that are appealing and easy to navigate. This course will cover emerging technologies with recent examples, new scenarios, and information on best practices.

Course Objectives

- To understand the fundamental components of an architecture, illustrating the interconnected nature of these systems
- To know about the latest concepts of the social web including Tagging, Folksonomies, Social Classification, and Guided Navigation
- To understand the tools, techniques, and methods that takes from research to strategy and design to implementation
- A series of short essays that provide practical tips and philosophical advice for those who work on information architecture
- The business context of practicing and promoting information architecture, including recent lessons on how to handle enterprise architecture
- Case studies on the evolution of large information architectures, illustrating best practices along the way

Course Contents

Defining and Practicing Information Architecture, The Anatomy of an Information Architecture, Organizing Systems, Labeling Systems, Navigation Systems, Search Systems, Thesauri, Controlled Vocabulary, and Metadata, Research and Strategy, Design and Documentation, Tools and Software, Enterprise Information Architecture.

Recommended Readings

1. Peter Morville, Luis Rosenfeld, Information Architecture for the World Wide Web – Designing Large Scale Web Sites, O'Reilly Media, Inc., 2006.

2. Duane Nickull, Dion Hinchcliffe and James Governor, *Web 2.0 Architectures: What Entrepreneurs and Information Architects Need to Know*, O'Reilly Media, Inc., 2009.
3. Steve Krug, *Don't Make Me Think! A Common Sense Approach to Web Usability*, New Riders Publishers, 2006.

CS749 Information Retrieval

(3 cr.hrs)

Course Description

A multibillion-dollar industry has grown to address the problem of finding information. Commercial search engines are based on information retrieval: the efficient storage, organization, and retrieval of text. This course covers both the theory and practice of text retrieval technology. A practical approach is emphasized and students will complete several programming projects to implement components of a retrieval engine.

Course Objectives

- Students will learn the underlying technology of search engines
- Gain practical experience building simple, but true-to-practice retrieval software
- Appreciate topics in the broad area of information retrieval, including evaluation, classification, cross-language retrieval, and computational linguistics

Course Contents

Introducing IR, IR and IE, Page ranking algorithms, Search engine architecture, Crawling Techniques, Crawler algorithms, Role of query engine and its interface between the search index, the user and the web, Modeling, Retrieval Evaluation: Models, Languages, Indexing, Searching, Query Languages and Operations, Text and Multimedia, Indexing and Searching, Parallel and Distributed IR, UI Visualization, Libraries and Bibliographical Systems, Digital Libraries

Recommended Readings

1. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, *Introduction to Information Retrieval*, Cambridge University Press. 2008.
2. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, *Modern Information Retrieval*, Addison Wesley Longman Publishing Co. Inc, 1999.
3. G. G. Chowdhury, *Introduction to Modern Information Retrieval*, Neal-Schuman Publishers, 2003.

CS750 Web Mining

(3 cr.hrs)

Course Description

The accessibility and ubiquity of content on the WWW has changed how we perceive information. Web mining aims to discover useful information or knowledge from Web hyperlinks, page contents and usage data. Due to the richness and diversity of information and other Web specific characteristics, Web mining is not just an application of data mining. Web mining has developed many of its own methods, ideas, models and algorithms. This course provides an in-depth coverage of how to extract and discover information within the Web and how we use the Web.

Course Objectives

- To introduce Web mining technology from a practical point of view and to obtain a solid grasp of how techniques in Web mining technology can be applied to solve problems in real-world applications
- To provide students with a sound basis in Web data mining tasks and techniques
- To ensure that students are able to read, and critically evaluate Web mining research papers
- To ensure that students are able to implement and to use some of the important Web mining algorithms
- To design and develop a large scale web crawler and a mini search engine

Course Contents

Data Mining and Knowledge Discovery, Web Usage Mining, Privacy Issues, Web Content Mining, Web Structure Mining and Link Analysis, Social Network Analysis, Web Mining Applications - Data integration for e-commerce and Web personalization and recommender systems, Web data warehousing, Review of tools, applications, and systems

Recommended Readings

1. Zdravko Markov and Daniel T. Larose, *Data Mining the Web: Uncovering Patterns in Web Content, Structure, and Usage*, Wiley-Interscience, 2007.
2. Bing Liu, *Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data*, Data-Centric Systems and Applications Series, Springer, 2009.
3. Gordon S. Linoff and Michael J. A. Berry, *Mining the Web: Transforming Customer Data into Customer Value*, Wiley Publishers, 2002.
4. Mark Levene, *An Introduction to Search Engines and Web Navigation*, Pearson Education, 2005.
5. Soumen Chakrabarti, *Mining the Web: Discovering Knowledge from Hypertext Data*, Morgan-Kaufmann Publishers, 2002.
6. Pierre Baldi, Paolo Frasconi, Padhraic Smyth, *Modeling the Internet and the Web: Probabilistic Methods and Algorithms*, John Wiley and Sons Ltd, 2003.

CS751 Ontology Engineering

(3 cr.hrs)

Course Description

The general objective is to provide students with a sound grounding of scientific, methodological and technological fundamentals in Ontological Engineering and the Semantic Web areas. This knowledge will be later used to build applications that can integrate, combine and infer heterogeneous and distributed information.

Course Objectives

By the end of the course, as a minimum, the student will be able to:

- Build and implement a small ontology that is semantically descriptive of their chosen problem domain
- Write JAVA code that can access, use and manipulate the ontology
- Represent data from a chosen problem in XML with appropriate semantic tags obtained or derived from the ontology
- Depict the semantic relationships among these data elements using Resource Description Framework (RDF)
- Write a web services application that “discovers” the data and/or other web services via the semantic web (which includes the RDF, data elements in properly tagged XML, and the ontology)

Course Contents

Ontology: Introduction, Components, Types, Design Principles

Outstanding Ontologies:

Knowledge Representation Ontologies: OKBC, RDFS, DAML+OIL, OWL

Top-Level Ontologies Cyc, SUMO

Linguistic Ontologies: WordNet etc.

Domain Ontologies: PIM, eCommerce, Knowledge Representation, etc

Ontology Engineering Methodologies

Axioms, Rules and Inference

Ontology Merging, Ontology Evolution

Languages for Building Ontologies

Ontology Tools and Tool Suits

Recommended Reading

1. Asuncion Gomez-Perez, Oscar Corcho, and Mariano Fernandez-Lopez , Ontology Engineering: with examples from the areas of Knowledge Management, e-Commerce and the Semantic Web, Advanced Information and Knowledge Processing Series, Springer 2004.
2. Jan LG Dietz , Enterprise Ontology: Theory and Methodology, Springer, 2006.

3. Raj Sharman, Rajiv Kishore and Ram Ramesh, *Ontologies: A Handbook of Principles, Concepts and Applications in Information Systems*, Integrated Series in Information Systems, Springer 2007.

CS752 Description Logic (3 cr.hrs)

Course Description

This course presents the main motivations for the development of Description Logics (DL) as a formalism for representing knowledge, as well as some important basic notions underlying all systems that have been created in the DL tradition.

Course Objectives

After completion of this course, a student will know:

- The relationship between Description Logics and earlier systems and the key problems encountered with the older efforts
- The basic features of Description Logic languages and related reasoning techniques
- Knowledge representation using Description Logics
- The development of some implemented knowledge representation systems based on Description Logics
- How applications built with such systems are developed

Course Contents

Introduction: Knowledge Representation, From Networks to DL

Theoretical Aspects: Basic Description Logics, Complexity of Reasoning, Relationship with other formalisms, Expressive DL, Extension to DL

Implementation: From DL to KR, DL Systems, Implementation and Optimization Techniques

Applications: Conceptual Modeling with DL, Applications in Software Engineering, Medical Informatics, Digital Libraries, Web-based Information Systems, NLP, Databases, etc

Recommended Readings

1. Franz Baader, Diego Calvanese and Deborah McGuinness, *The Description Logic Handbook: Theory, Implementation and Applications*, Cambridge University Press, 2007

CS753 Soft Computing (3 cr.hrs)

Course Description

Soft Computing refers to a collection of computational techniques in computer science, artificial intelligence and engineering disciplines which attempt to study, model and analyze complex

problems - those for which more conventional methods have not yielded low cost, analytic and complete solutions. Unlike conventional computing, soft computing techniques are tolerant of imprecision, uncertainty and approximations.

Course Objectives

The objective of the course is to design and develop intelligent systems in the framework of soft computing, and apply to some general and scientific application-driven environments. Students who successfully complete this course will be able to

- Have a general understanding of soft computing methodologies, including artificial neural networks, fuzzy sets, fuzzy logic, fuzzy clustering techniques and genetic algorithms
- Study neuro-fuzzy control and inference systems
- Have an insight into the genetic algorithms and computing, one of the powerful techniques to tackle hard optimization problems;
- Design and development of certain scientific and commercial application using computational neural network models, fuzzy models, fuzzy clustering applications and genetic algorithms in specified applications
- Study all these techniques from the point of view of the world wide web

Course Contents

Introduction, Tools, Fuzzy Reasoning, Fuzzy Inference, Genetic Algorithms and its Applications, Fuzzy Logic, Applications, Neural Networks and its Applications, Learning (Supervised/Unsupervised, etc), Clustering and Classification, Case-based Reasoning and its Applications, Hybrid Systems, Adaptivity, When to use a technique, Knowledge Management

Recommended Readings

1. Zongmin Ma, Soft Computing in Ontologies and Semantic Web, Studies in Fuzziness and Soft Computing Series, Springer, 2006.
2. N.K. Sinha, Naresh K. Sinha and Madan M. Gupta, Soft Computing and Intelligent Systems: Theory and Applications, Academic Press, 1999.

CS754 Web Engineering

(3 cr.hrs)

Course Description

The World Wide Web has become a major delivery platform for information resources. Many applications continue to be developed in an adhoc way, contributing to problems of usability, maintainability, quality and reliability. This course examines systematic, disciplined and quantifiable approaches to developing of high quality, reliable and usable web applications. The course introduces the methodologies, techniques and tools that support their design, development, evolution, and evaluation.

Objectives

After completion of this course, a student will be able to:

- Have knowledge of web specific technologies and tools
- Understand the difference between traditional software engineering and web software engineering
- Know about the different application models and architectures of web applications
- Have in-depth knowledge of web application development and web project management

Course Contents

Web Applications:

Introduction, categories, Characteristics

Requirements Engineering for Web Applications

Web Application Modeling:

Requirements, content modeling, hypertext modeling, presentation modeling, methods and tools

Web Application architectures:

Introduction, components, layered and data-aspect architectures

Technologies for web applications:

Client side, server side, communication, and document specific technologies

Testing, operation and maintenance of web applications

Web Project management

Web Application Development Process

Advanced Topics:

Usability, performance, security of web applications, semantic web, semantic web services

Recommended Readings

1. Gerti Kappel, Birgit Pröll, Siegfried Reich, and Werner Retschitzegger, Web Engineering: The Discipline of Systematic Development of Web Applications, John Wiley & Sons, 2006
2. Gustavo Rossi, Oscar Pastor, Daniel Schwabe and Luis Olsina, Web Engineering: Modelling and Implementing Web Applications, Springer Verlag HCIS, 2007.
3. Emilia Mendes and Nile Mosley, Web Engineering, Springer-Verlag, 2005.
4. Woojong Suh, Web Engineering: Principles and Techniques, Idea Group Publishing, 2005.
5. Jim Conallen, Building Web Applications with UML, Pearson Education, 2003.
6. Leon Shlkar and Richard Rosen, Web Application Architecture – Principles, Protocols and Practices, John Wiley & Sons, 2003.

CS760 Morphology of Natural Language

(3 cr.hrs)

Objectives

After the completion of this course a student will be able to have a strong understanding of the following:

- Morphology and its types
- Different phenomena involved in morphology
- Analyzing inflections and derivations
- Computational models for morphological analyzers and synthesizers
-]Xerox tool for the implementation of morphological analyzers and synthesizers
- Implementation of morphological analyzers and synthesizers

Introduction to Morphology

What is morphology, morphemes, introduction to morphological analysis.

Words and Lexemes

What is word, types of words, inflection Vs derivation, Item-and-arrangement, Item-and-process, the lexicon.

Morphology and Phonology

Allomorphs, prosodic morphology, Morphophonology

Derivation

Derivation and lexicon, derivation and semantics

Inflection

What is inflection, inventory of Inflectional morphology types, Typology

Morphological productivity

Introduction, Productivity and structure, degrees of productivity

Practical

- Regular expressions
- Finite automata
- FST
- The XFST interface
- The LEXC language
- Planning and managing finite state projects

Recommended Readings

1. Daniel Jurafsky and James H. Martin. (2000). "Speech and Language Processing". Pearson Education, Inc.
2. Mark Ronoff and Kirsten Fudeman. (2005). "What is Morphology?". Blackwell Publishing.

CS761 Syntax of Natural Language

(3 cr.hrs)

Objectives

At the end of this course, the students will be able to know about:

- The structure of phrases in a language
- The structure of sentences in a language
- The structure of phrases and sentence in local languages
- The processing of phrases and sentences by a computer

Language theory

Natural Languages, Regular languages, Formal languages

Grammar

Definition, elements, The Chomsky Hierarchy

Constituent Structure

Ambiguity, Constituency, Hierarchy, Syntactic categories, Tree diagrams,

Noun Phrases

Adjuncts, Complements and adjuncts of N, Determiners, Adjectives and Adjective Phrases (AF), Possession and recursion, English NP structure

Case and Agreement

Case, Agreement

Tense, Aspect and Modality

Tense, Aspect, Perfect Vs. Perfective
Combinations of tense and aspect, Mood, Modality

Special sentence types

Direct vs. Indirect speech acts, basic word order, Commands, Questions, Negation

Subordinate clauses

Coordinate vs. subordinate clauses, complement clauses, Direct vs. Indirect speech, Adjunct clauses, Relative clauses

Indirect object and Secondary objects

The use of Syntax in Corpus development

Word classes, Part-of-Speech tagging

Parsing

Parsing with Context-Free Grammars, Unification Parsing, Lexicalized and Probabilistic Parsing

Recommended Readings

1. Daniel Jurafsky and James H. Martin. (2000). "Speech and Language Processing". Pearson Education, Inc
2. Paul R. Kroeger. (2005). "Analyzing Grammar: An Introduction". Cambridge University Press.

CS762 Corpus Linguistics

(3 cr.hrs)

Objectives

At the end of this course, the students will be able:

- To understand how a corpus can be developed and processed?
- To know what is in existing corpus?
- To know different types of corpora and their day to day applications

Corpus Linguistics basics

What is a corpus, Corpus-based vs. intuition-based approach, corpus-based vs. corpus-driven approaches

Corpus characteristics

Representativeness, Balancing, Sampling

Corpus Mark-up

Introduction, Rationale for corpus mark-up, corpus mark-up schemes, character encoding

Corpus Annotation

Introduction, Corpus annotation, types of corpus annotations, embedded vs. standalone annotation

Multilingual corpora

Introduction, terminological issues, corpus alignment

Using available corpora

Introduction, general corpora, specialized corpora, written corpora, spoken corpora, synchronic corpora, learner corpora, monitor corpora

Corpora and applied linguistics

How to Develop a Corpus?

Corpus development methodology, Concordancer

Practical

XML language

Recommended Readings

1. Tony McEnery, Richard Xiao and Yukio Tono. (2006). "Corpus-Based Language Studies: An advanced resource book". Routledge Applied Linguistics.
2. Tony McEnery and Andrew Wilson (2001). "Corpus Linguistics" Edinburgh University Press, 2nd Edition

CS763 Machine Translation

(3 cr.hrs)

Objectives

At the end of this course, the students will be able to know about:

- The translation of natural languages by a computer
- The difficulties involved in machine translation
- The applications of machine translation

Linguistic aspects

(mainly transfer problems, ambiguities, lexical gaps etc.)

Computational problems of machine translation

Paradigm of machine translation

(direct, transfer, interlingua)

Statistical based MT

Example-based MT

Evaluation of Machine translation

Examples of MT Systems

Recommended Readings

1. Yorick Wilks (2008) "Machine translation : its scope and limits", New York : Springer
2. Philipp Koehn (Spring 2009) "Statistical Machine Translation", Cambridge University Press.

CS764 Mobile Ad Hoc Networking

(3 cr.hrs)

Course Description

This course mainly addresses the problem of routing (how to direct a packet from a source machine to a destination machine), topology control (how to adjust network communication links as the environment changes such that the network capacity can be maximized), and medium access control (how to share the common resources among multiple users) in wireless mobile ad hoc networks.

Course Objectives

- To study and understand wireless mobile technologies.
- To study and understand mobile adhoc networks.

Course contents

Routing, Topology Control and Medium Access Control in Wireless Mobile Ad Hoc Networks, Cross-layering, QoS, and Security, Mobile Ad-Hoc Networking with a View of 4G Wireless, IEEE 802.11 in Ad Hoc Networks, Protocols, Performance and Open Issues, Scatternet formation in Bluetooth Networks, Broadcasting and Activity Scheduling, Location Discovery, QoS sensitive Routing in Mobile Multimedia Ad Hoc Networks.

Recommended readings

1. Toh, Ad Hoc Mobile Wireless Networks, Protocols and Systems, Prentice Hall, 2002, ISBN 0-13-007817-4.
2. George Aggelou, Mobile Ad Hoc Networks: From Wireless LANs to 4G networks, The McGraw-Hill Companies, Inc., 2005, ISBN 0-07-141305-7
3. Stefano Basagni, Marco Conti, Silvia Giordano, Mobile Ad-Hoc Networking, IEEE Press, 2004, ISBN 0-471-37313-3
4. Extensive use of current research publications and literature.

CS765 Network Management and QoS Provisioning

(3 cr.hrs)

Course Description

This course introduces QoS issues and management of QoS in different types of networks. This course also emphasizes on multimedia QoS issues.

Course Objectives

- To understand QoS principles.
- To study QoS issues w.r.t network management.
- To study QoS issues in multimedia management.

Course Contents

Introduction to QoS issues Course introduction and review . QoS in Frame relay. QoS routing and Admission control. Scheduling algorithms. QoS in ATM networks. Scheduling in Input Queued switches. QoS in the Internet. MPLS (Multi-Protocol Label Switching. Internet Multimedia. Network management. SDH and WDM. Capacity planning. Fault management. Voice coding. Audio coding. Video coding. RTP (and RTCP) protocol. MPEG reference documentation.

Recommended readings

1. James F. Kurose , Keith W. Ross “Computer Networking: A Top-Down Approach
2. Featuring the Internet”, Addison Wesley, 2004
H.Chao, X.Guo, "Quality of Service Control in High-Speed Networks", John Wiley & Sons, Inc, 2001
3. Current research publications and literature

CS766 Business Intelligence

(3 cr.hrs)

Course Description

Business Intelligence is a new field. This course discusses current issues highlighting business databases. The course will provide an insight into the business intelligence and techniques of improvement in business intelligence.

Course Objectives

- To introduce information systems and business intelligence.
- To study advance techniques in ETL process.

Course Contents

Introduction to Information Systems and Business Intelligence, Design of Relational Databases, Querying, Securing and Administrating databases, Data Transformation, Advance Techniques in ETL Process, Introduction to the Unified Dimensional Model (UDM), Dimensions, Cubes and their features, The MDX Language and KPIs, Excel Pivot Table with Analysis Server, Reporting and Visualization, Analysis with Data Mining and Excel 2007/SSAS/SAS

Recommended readings

1. Elizabeth Vitt, Michael Luckevich, Stacia Misner “Business Intelligence: Making Better Decisions Faster” Publisher: Microsoft Press, Publication Date: May 17, 2002, ISBN 0-7356-1627-2
2. Cindi Howson “Successful Business Intelligence: Secrets to Making BI a Killer App” Publisher: The McGraw Hill Companies, Publication Date: November 26, 2007 Edition: 1, ISBN: 978-0-07-149851-7
3. Thomas H. Davenport, Jeanne G. Harris, Robert Morison “Analytics at Work: Smarter Decisions, Better Results” Publisher: Harvard Business School Publishing Corporation Publication Date: February 8, 2010, ISBN 978-1-4221-7769-3
4. Swain Scheps “Business Intelligence for Dummies” Publisher: Wiley Publishing, Inc. Publication Date: January 10, 2008, ISBN 978-0-470-12723-0
5. Current research publications and literature

<p>CS767 Mobile Application Development</p> <p>(3 cr.hrs)</p>

Course Description

The course is aimed to provide a thorough understanding of various mobile technologies available for creating mobile applications. This course first briefly introduces the popular technologies for mobile phones namely, JavaME (J2ME) and Python/C++ (Symbian). It then focuses on Smartphone application development using Android. The Android platform is an open source mobile and embedded device platform from Google. Currently there is rapid growth in the number of Android based mobile devices being released on all the major mobile phone carriers around the world, with a common development platform and application market for third party developer applications. The aim of this course is to teach students mobile apps development on the world's most popular platform.

Course Objectives

When students complete this course, they will be able to:

- Understand the evolution and capabilities of mobile phones, mobile communication technologies and mobile applications
- Learn how to design and build Android Mobile applications
- Gain a thorough knowledge and understanding of the Google Android framework and platform

Course Outline

Introduction to mobile computing, Java ME, Symbian and Smartphone, Introduction to Android OS, Android SDK and Eclipse, App Analysis, App details and lifecycle, User Interfaces, menus and dialog boxes, Graphics and sound, Saving state and internationalization, Settings and Permissions, Android Persistence, SQLite databases and custom views, Releases and Evaluation: Pre-Alpha Version, Alpha, Beta Releases
HTTP and web services, Location API: GPS and Google Maps API, Networking API
Accelerometer and other Android sensors, Background processing, Broadcast Receiver, Services, Alarms and Notifications, App widgets, Advanced user input, Testing apps, Android 3.x and beyond: the latest APIs and Android Best Practices, Selling Your Application and Advanced Android Topics, Android Vs. iPhone Vs. Others

Recommended readings

1. Programming the Mobile Web, Maximiliano Firtman. O'Reilly Media, Inc. 2010
2. Beginning Android 2, by Mark L. Murphy. Apress 2010.
3. Pro Android 2, Sayed Y. Hashimi, Satya Komatineni, and Dave MacLean. Apress 2010.
4. Professional Android™ Application Development, Reto Meier. Wiley Publishing, Inc. 2009.
5. Hello, Android: Introducing Google's Mobile Development Platform, Ed Burnette. The Pragmatic Programmers 2008.
6. Beginning Smartphone Web Development: Building JavaScript, CSS, HTML and Ajax-based Applications for iPhone, Android, Palm Pre, BlackBerry, Windows Mobile, and Nokia S60, Gail Rahn Frederick and Rajesh Lal. Apress, 2009.

<p>CS768 Advanced Wireless Network Security</p> <p>(3 cr.hrs)</p>

Course Description

This course looks at misbehavior of nodes, trust and its characteristics, reputation system goals and properties, classification of trust and reputation based systems, information gathering techniques, information dissemination, detection, response, Examples: watchdog and path raters, context aware mechanism, trust aggregation scheme, trusted routing schemes, collaborative reputation based systems, cooperation based models, observation based mechanism, distributed reputation based, beacon based system.

Course Objectives

- To study the security issues related to wireless network.
- To study the techniques used to solve classic security issues in wireless network.

Course Contents

Secure device association techniques, Reputation and trust based security mechanisms, Mobile Ad hoc Networks, Wireless Sensor Networks, Wireless mesh Networks, Countermeasure to

selfish misbehavior, countermeasure to greedy misbehavior, countermeasure to MAC layer DoS attacks, Cryptography based solutions, reputation based solutions, add-ons to existing solutions, countermeasure to specific attacks., Pre authentication and authentication models, Identity based key management schemes, Passive attacks, Active and Denial of service attacks, physical layer attacks, MAC layer security issues, Wireless Local Area Networks (WLANs): cross domain mobility adaptive authentication, AAA architecture and authentication.

Recommended readings

1. William Stallings , “Network security essentials”, Prentice Hall, 2004
2. Y. Xiao, X. Shen, D. Z. Du, “Wireless Networks security” signal and communication technology series, Springer series, 2007.
3. Current research publications and literature

<p>CS769 Wireless Sensor Networks</p> <p>(3 cr.hrs)</p>

Course Description

Smart environments represent the next evolution in harnessing computing power to better our lives. Wireless Sensor Networks are collections of spatially distributed autonomous devices to monitor environments. Typically the sensor devices are small, ranging from the size of a shoe box to ones that fit on your finger tip, and are limited in their computational, power resources, and computational abilities.

Course Objectives

- To provide a hands-on introduction to wireless sensor networks.
- To study wireless communications standards and protocols
- To study higher-level network services

Course Contents

To provides a hands-on introduction, RF Basics and Signal Encoding, Antennas and spread spectrum, Medium Access Control, Programming Motes & Localization Appln., 802.11, Bluetooth 802.15.4/Zigbee Programming motes, Canonical Problem: Localization and Tracking, Ad hoc Routing Protocols, Geographic, energy-aware routing, Attribute-based routing, Clustering, Topology, Time Synchronization, Localization, Sensor Tasking and Control, Sensor Network Databases, Sensor Network Platforms and Tools.

Recommended readings

1. Wireless Communications & Networks, 2nd Edition, William Stallings, 2004, ISBN: 0131918354.
2. Wireless Sensor Network: An Information Processing Approach, Feng Zhao and Leonidas Guibas, 2004, ISBN 1-55860-914-8

3. Fundamentals of Wireless Sensor Networks, Theory and practice, Walteneagus Dargie, Christian Poellabaur, John Wiley and Sons, Ltd, 2010
4. Current research publications and literature

<p>CS770 Empirical Methods in Software Engineering Research</p> <p>(3 cr.hrs)</p>

Course Description

Empirical software engineering is a hot topic among researchers in the field of software engineering. This course explores different research methods and techniques applied in software engineering research.

Course Objectives

- To make students understand the concepts of software engineering research and the different qualitative and quantitative research methods, their role, importance, and impact in the research.
- To introduce different methods to conduct research in software engineering so that the students can effectively and select an appropriate method for their work.

Course Contents

Concept of empirical research, concept of evidence-based software engineering, analyses methods (Qualitative, Quantitative and mixed approaches, Statistical analysis, Grounded theory), Controlled experiments (including Quasi-experiments), Case studies (both exploratory and confirmatory), Survey research (literature reviews, types, systematic literature review), Ethnographies, Action Research, Ethical issues in empirical studies of software engineering.

Recommended Readings

1. Guide to Advanced Empirical Software Engineering, Forrest Shull, Janice Singer, Springer | ISBN: 184800043X, 2006
2. Extensive use of latest available online resources.
3. A selection from classical research papers of renowned researchers in the field of software engineering will also be used as reference to the course.

CS771 Software Requirements Engineering (3 cr.hrs)

Course Description

This course will help the students to understand requirements quality and recognize basic types of requirements. The course is aimed at introducing the role of requirements engineering in an agile software development environment and understand the best practices. The course also discusses some of the latest tools used in requirements engineering process. It also provides latest information on best practices of requirements engineering through literature review.

Course Objectives

- To understand the principles of requirements engineering process
- To understand the role of requirements analysis in achieving successful project outcomes.

Course Contents

Basic concepts, issues and terminology, Categorizing requirements, Enterprise analysis, Identifying the sources, Coping with the real world problems, Finding the stakeholders, Eliciting requirements, Issues in requirements elicitation, user/customer oriented software requirements, developer oriented software requirements, analyzing the requirements, Documenting requirements, Standards for requirement documents, Modeling techniques, Representative requirements definition methods, Computer support tools for model development and prototyping, Agile requirements engineering, Case studies, literature Review.

Recommended Readings

1. Gerald Kontonya and Ian Sommerville: Requirements Engineering: Processes and Techniques, John Wiley and Sons, 2002
2. Requirements Engineering, 3/Ed, Elizabeth Hull, Ken Jackson, Jeremy Dick, Springer, 2010
3. Agile Software Requirements: Lean Requirements Practices for Teams, Programs, and the Enterprise, Dean Lengwell, Don Widrig, Addison-Wesley Professional, 2010

CS772 Advanced Software Project Management (3 cr.hrs)

Course Description

This course is aimed at increasing and broadens the knowledge of project management principles. The students will be able to understand how software development is integrated with other business activities and how social and environmental factors impact development. The course also provides the knowledge of agile software project management and management tools. It also provides a practical overview of project management with the help of case studies.

Course Objectives

- To build increased capability in students to manage projects successfully.
- To broaden the knowledge of project management principles.
- To be able to estimate, plan, and monitor the progress, and perform a project risk assessment for a software development project.

Course Contents

Software project planning, project management methodologies, Introduction and Overview: Project estimation, Project scheduling, the roles, Project management issues, the features/cost/time dilemma, Scope Management, Time Management, Cost Management, Quality Management, Human Resource Management, Communications Management, Risk Management, Change Management, Integration Management, Managing the software process, Project management plans (Standards: IEEE, ISO standards, Others.), Agile Software Project management, Roles and Responsibilities, Agile lifecycle, Communications and feedback loops, Prioritization and Time boxing, Requirements and Estimating, Overview of Lean-Agile, Scrum Overview Lean-Agile Project Manager / Scrum Master Role, Release Planning, Metrics, Software project reviews; Inspections, Walkthroughs, Code reviews, Pair programming, Project retrospectives, Portfolio Management, Success factors in management, Project management tools: why and what to automate, or support by tools, literature review.

Recommended readings

1. Applied Software Project Management, Andrew Stellman, Jennifer Greene, O'Reilly Media November 2005
2. Managing Agile Projects, Sanjiv Augustine, Prentice Hall PTR, 2005
3. Agile Project Management with Scrum, Ken Schwaber, Microsoft Press, 2004
4. Agile Project Management: Creating Innovative Products, Jim Highsmith, Addison-Wesley Professional, 2004
5. Current research publications and literature.

CS773 Emerging Technologies in Software Engineering

(3 cr.hrs)

Course Description

This course takes an overview of the latest developments and research in the field of software engineering. New ideas being presented in flagship software engineering conferences and journals are discussed. The entire course will be based upon the literature review of topics from the research

papers presented in Software Engineering conferences and published in journals in the recent years.

Course Objectives

- To keep the students up to date with the latest advancements in the field of software engineering.
- To be able to discuss current issues in software engineering research.

Course Contents

Following are some of the proposed topics, the instructor may add any other topic(s) of interest from the latest technologies and may cover two or more of the following topics in detail: Advances in Security Engineering, Knowledge management issues in software engineering, Agile Knowledge Management, Software testing, End user software engineering, Patterns and frameworks, Knowledge Based Software Engineering, Semantic Web Enabled Software Engineering, Literature review and support tools (if apply)

Recommended readings:

1. Current research publications and literature.

<h2>CS774 Usability Engineering</h2> <p>(3 cr.hrs)</p>

Course Description

Usability engineering is integral to the design process of an individual software product or service in terms of how the end-users perceive and use that product or design. The objective of this course is to provide students an advanced understanding of the role of usability engineering in the software design process. The students will also have practical experience with tools and methods that are used as part of the usability engineering process.

Course Objectives

- To understand the concept of usability engineering and its importance in software development.
- To learn the techniques of usability engineering.

Course Contents

Usability Definitions, Justification for Usability, User Centered Design, Interaction Design, Users, Tasks, Usability Engineering, Interface Evaluation, Usability Methods, Usability Testing, Usability Data Analysis and Reporting

Recommended readings

1. Rubin, J. and Chisnell, D. Handbook of Usability Testing. Wiley Press. 2008. ISBN: 978-0-470-18548-3.

2. Saer, D. Designing for Interaction, New Riders Press. 2007, ISBN: 0-321-43206-1.
3. Proctor, R.W. and van Zandt, T. Human Factors in Simple and Complex Systems. CRC Press. 2008, ISBN: 978-0-8058-4119-0
4. Latest research publications and literature.

CS775 Agile Software Development

(3 cr.hrs)

Course Description

This course describes agile software methodologies and discusses how to select the appropriate methodology for a project. The course covers Extreme Programming methodology in detail. The students will work in teams to implement and understand the process of agile software development and to simulate the real work environment.

Course Objectives

- To understand the principals behind agile methodologies
- To gain knowledge of new vocabulary for describing methodologies,
- To understand the concept of adjusting a methodology for a project

Course Contents

Waterfall vs. Agile, Introduction to agile methodologies, Iterative Development, Agile Development, Agility What Does It Mean?, The Agile Manifesto, The 12 Agile Principles, Agile Practices, Extreme Programming(XP): Values, principles and practices, User Stories and Requirements, Acceptance testing, planning and estimation, Estimation techniques, Planning for value, Project scheduling, Agile development, Pair programming, Release, Buffering plans for uncertainty, Tracking and communication, Retrospectives, Balancing agility and discipline.

Recommended readings

1. Agile Estimating and Planning Mike Cohn 1 edition Prentice Hall, 2005
2. User Stories Applied: For Agile Software Development, Mike Cohn Addison-Wesley Professional, 1st edition, 2004
3. Extreme Programming Explained: Embrace Change (2nd Edition) Kent Beck, Cynthia Andres Addison-Wesley Professional, 2004
5. Agile Software Development, Alistair Cockburn, Addison-Wesley Professional, 2001
6. Current research publications and literature.

CS776 Software System Quality

(3 cr.hrs)

Course Description

The objective of this course is to study in detail the issues involved in software quality engineering. The course focuses on current practice, research and trends in Quality including how to assure it and verify it, and the need for a culture of quality. Avoidance of errors and other quality problems, Inspections and reviews, Testing, verification and validation techniques. Process assurance vs. Product assurance. Quality process standards. Product and process assurance. Problem analysis and reporting. Statistical approaches to quality control. Economics of testing, verification and validation activities, and software quality improvement through systematic test planning, design and executions, problem reporting and resolutions, and test documentation. Establishing software quality goals and improvement measurement.

Course Objectives

- To study the concepts of software quality.
- To make a thorough study of different testing techniques which ensure software system quality
- To learn different statistical approaches to quality control.

Course Contents

What Is Software Quality: Quality Assurance, Quality Engineering, Software testing: Testing Concepts, Issues, and Techniques, Test Activities, Management, and Automation, Coverage and Usage, Testing Based on Checklists and Partitions, Input Domain Partitioning and Boundary Testing, Coverage and Usage Testing Based on Finite-State Machines and Markov Chains, Control Flow, Data Dependency, and Interaction Testing, Testing Techniques: Adaptation, Specialization, and Integration. Quality assurance beyond testing: Defect Prevention and Process Improvement, Software Inspection, Formal Verification, Fault Tolerance and Failure Containment, Comparing Quality Assurance Techniques and Activities.

Recommended readings

1. Jeff Tian , Software Quality Engineering: Testing, Quality Assurance, and Quantifiable Improvement, Wiley-IEEE Computer Society Press, 2005
2. Boris Beizer, Software Testing Techniques (second edition), Dreamtech, 2002
3. Latest research publications and literature

CS777 Software Configuration Management

(3 cr.hrs)

Course Description

Software configuration management is one of the crucial functions in software project management; hence it has become an important area of research in software engineering. This course is designed to familiarize the students with configuration management requirements, and to equip them with basic skills of configuration management. Also, it will help the, to understand how to develop configuration management plans and procedures, and to establish and maintain a successful Configuration control board. The course also gives an insight into agile configuration management environments.

Course Objectives

- To understand the concepts of configuration management.
- To discuss different phases of configuration management w.r.t the software development lifecycle.
- To study different tools which are used to aid the software configuration management process.

Course Outline

Evolution in the Software Life Cycle, Importance Of Configuration Management, Configuration Management as a Controlling Tool, Requirements for the Success of Configuration Management, SCM Phases, Configuration Identification and Control, SCM Accounting and Auditing, SCM Plans, Implementation, Operations, Organization, Build Management, Process Management, Teamwork, Release Management, Version Control, Metrics, Documentation Management, SCM Tools: SVN, CVS, GIT, etc. Literature Review.

Recommended readings

1. Configuration Management Best Practices: Practical Methods that Work in the Real World Robert Aiello, Leslie Sachs Addison-Wesley Professional, 2010
2. Configuration Management Principles and Practice, Anne Mette Jonassen Hass yddison-Wesley Professional; 1st edition, 2003
3. Software Configuration Management Patterns: Effective Teamwork, Practical Integration Stephen P. Berczuk, Brad Appleton, Kyle Brown, Addison Wesley Professional, 2003

CS778 Software Engineering Laboratory

(3 cr.hrs)

Course Description

The course is basically designed for developing software design and development skills while gaining knowledge about advanced research methodologies. The students will work on a software development project relating to an application area of their choice, incorporating object oriented concepts, database programming, web and multimedia application development using data validation and error handling techniques, and interface design techniques, Shell programming for Windows/Linux, etc. The project and project documentation will be evaluated for grades at the end of the semester.

Course Objectives

- To make the students improve their software design and development skills.
- To make the students have hands on experience of latest software development tools and techniques.
- To make them understand the software development process as a whole to give them an understanding of the practices used in software development industry.

Course Contents

Specifying, designing, and implementing real-life software applications following software development methodologies. Each student/team is expected to select an area of greatest interest and implement a related general interest non trivial software application. Software application areas covered include. Multimedia, Client server, Internet/network computing, database systems, objects oriented modeling, software quality documentation, and testing and project management. The students are supposed to understand the concepts and have a practical implementation of best programming practices such as a) design patterns, b) coding techniques, c) coding standards, d) incremental programming, e) peer reviews. Use of Repositories and version control is also a requirement.

Recommended readings

1. Object-Oriented Software Engineering Using UML, Patterns, and Java (3rd Edition)
Bernd Bruegge, Allen H. Dutoit Prentice Hall; 2009
2. UML distilled, M. Fowler, 2nd Ed., Addison-Wesley 2000
3. Software architecture and the use of patterns: How Christopher Alexander's The timeless way of building can be applied to software design, S. Caddel, Tech. Report CTU-CS-2001-06, 2011
4. Reference for software development tools will be taken from internet.

CS779 Information Security

(3 cr.hrs)

Course Description

The protection of information assets underpins the commercial viability and profitability of all enterprises and the effectiveness of public sector organizations. It should not be left to chance. If you work in an organization concerned (directly or indirectly) with valuable information assets, this practical course will enable you to understand and manage strategic and operational aspects of information security, including IT governance and risk analysis and management. It will also provide the knowledge and skills needed to plan the implementation of an information security management system that provides efficient, effective safeguards and responds to your organization's needs.

Course Objectives

- Understand contemporary issues in information security management
- Analyze and prioritize information security risks
- Identify countermeasures and review techniques appropriate to the management of information security risks
- Understand the policy and technology trade-offs involved in developing information security systems of adequate quality
- Locate, read, comprehend and evaluate developments in the field as they appear in contemporary professional and research publications.

Course Contents

Security management: need, aims and objectives of security management, various approaches to solve security problems

Cryptography and security mechanisms: main types of cryptographic mechanism, security services, key management, cryptographic algorithms.

Network security: Networking security technologies, user identification techniques, authentication protocols and key distribution mechanisms, security solutions for a variety of types of practical networks, include LANs, WANs, proprietary computer networks, mobile networks and electronic mail.

Computer security: security requirements/policy, security models, security features and mechanisms in operating systems, security-related issues of computer architecture, security of middleware, software protection and web security.

Secure electronic commerce and other applications

Standards and evaluation criteria

Database security: concurrency control in distributed databases, methods for concurrency control and failure recovery in distributed databases and the interaction between those methods and security requirements, adapting access control policies to relational and object-oriented databases.

Information crime: history, causes, development and repression through studies of surveys, types of crime, legal measures, and system and human vulnerabilities, effects of computer crime, motives and attitudes of hackers and other computer criminals.

Recommended Readings

1. Mark Stamp, Information Security – Principles and Practice, Wiley-Interscience Publishers 2003.
2. Ross J. Anderson, Security Engineering: A Guide to Building Dependable Distributed Systems, Wiley Publishers, 2008.
3. Timothy P. Layton, Information Security: Design, Implementation, Measurement, and Compliance, Auerbach Publications, 2006.
4. Harold F. Tipton, Micki Krause, Information Security Management Handbook, Auerbach Publications, 2008.

CS780 Real-Time Systems

(3 cr.hrs)

Course Description

Real-time systems play a crucial role in many applications, such as avionic control systems, automotive electronics, telecommunications, industrial automation, and robotics. Such safety-critical applications require high reliability in timing assurance to prevent from serious damage to the environment and significant human loss.

Course Objectives

The objective of this course is to bring students into the position to understand the broad concept of real-time systems. The course aims to provide a practical understanding for industry and tries to stimulate research interest. At the end of the course the students should be able to:

- Understand and apply the fundamental concepts of real-time systems
- Explain and address the fundamental problems of real-time systems
- Analyze and partially design real-time systems

Pre-Requisites: Operating Systems

Course Contents

The following topics will be covered in the course:

- Introduction to Real Time Systems: basics
- Task scheduling
- Periodic task management
- Schedulability Analysis
- Aperiodic server mechanisms
- Accessing shared resources
- Predictable communication mechanisms
- Limits of hard real time systems
- Flexible real time systems
- Programming real time applications

Recommended Readings

1. Burns, A. & Wellings, A. J. (2009). Real-Time Systems and Programming Languages: ADA 95, Real-Time Java, and Real-Time POSIX. 4th edition, Addison-Wesley Longman Publishing Co., Inc., Boston, MA, USA
2. Buttazzo, G. (2011). Hard Real-Time Computing Systems: Predictable Scheduling Algorithms and Applications. Springer

CS781 Parallel Programming for Multicores (3 cr.hrs)

Course Description

The introduction of multicore chips into the computing market has created a revolution in the software industry. To benefit from increases in hardware performance, software must be parallel. The purpose of this course is to teach the next generation of programmers to develop exciting new applications that can take advantage of on-chip parallelism.

Course Objectives

This course will provide an introduction to parallel programming with a focus on the techniques that are most appropriate for multicore architectures and the use of parallelism to improve program performance.

Prerequisites

Computer architecture, Operating Systems, C programming language or equivalent.

Course Contents

The following topics will be covered in the course:

- Introduction to Parallel Architecture
- Parallel programming paradigms and issues
- The multicore revolution
- Parallel programming using shared memory
- Parallel programming using distributed memory
- Multi-Threading: OS threads, Posix threads and Java threads
- OpenMP for shared memory multiprocessors
- Message passing interface (MPI)
- Multicore Communication API

Recommended Readings

1. Pacheco, P. (2011). An Introduction to Parallel Programming. Morgan Kaufmann.
2. Rauber, T. & Runger, G. (2010). Parallel Programming: for Multicore and Cluster Systems. Springer.

CS782 Concurrent and Real Time Programming

(3 cr.hrs)

Course Description

Many real-time systems are inherently concurrent. In the past, software controlling these systems have used sequential frameworks. The result has been systems which are inflexible, difficult to design and costly to maintain. Having concurrency supported explicitly by a programming language makes an enormous difference to the expressive power of that language. The Java programming language is one of the few standard concurrent object-oriented programming languages. Furthermore, the Real-Time Specification for Java has facilities designed to cope with the special demands of real-time systems.

Course Objectives

This course provides an in-depth study on both the concurrency and the real-time facilities of Java (including the Real-Time Specification for Java). After the course students should be able to:

- Analyze requirements for programming concurrent and real-time systems.
- Evaluate strengths and weaknesses of the Java concurrency model and how it can be used to facilitate the programming of concurrent systems.
- Understand how Java can be restricted for Real-Time Systems.
- Develop real-time software in Java.

Prerequisites

Operating systems, Java programming language or equivalent.

Course Contents

The following topics will be covered in the course:

- The requirements for real-time programming and changes made to Java for real-time programming.
- Multi-threaded programming in Java
- Schedulable Objects in RTSJ: Real-time threads, No Heap Real-time threads, Asynchronous event handlers.
- Memory management in RTSJ: Scoped memory areas, Immortal memory and the Java Heap
- Clocks and high resolution timers in RTSJ
- Asynchronous transfer of control (ATC)
- Raw and physical memory access

Recommended Readings

1. Wellings, A. (2004). Concurrent and Real-Time Programming in Java. John Wiley & Sons
2. Dibble, P. C. (2008). Real-Time Programming with the Java Platform. Prentice Hall PTR, Upper Saddle River, NJ, USA
3. Bollella, G. & Gosling, J. (2000). The Real-Time Specification for Java. Computer 33, 47–54