ಮೈಸೂರು ವಿಶ್ವವಿದ್ಯಾನಿಲಯ

University of Mysore

(Estd. 1916)

M.Phil in COMPUTER SCIENCE and TECHNOLOGY

Flexible
Choice Based
Credit System
(FCBCS)

UNIVERSITY OF MYSORE

Department of Studies in Computer Science

Manasagangotri, Mysuru-570 006

Regulations and Syllabus

M.Phil in COMPUTER SCIENCE AND TECHNOLOGY

UNIVERSITY OF MYSORE

GUIDELINES AND REGULATIONS LEADING TO

M.Phil in Computer Science and Technology

Programme Details

Name of the Department	:	Department of Studies Computer Science
Subject	:	COMPUTER SCIENCE AND TECHONOLOGY
Faculty	:	Science and Technology
Name of the Programme	:	M.Phil in Computer Science and Technology

Program Outcome

After successful completion of M.Phil degree, the graduates will be able to:

- Make original scientific contributions that have both practical significance and a rigorous, elegant theoretical grounding that underpins the various areas of Computer Science and Technology.
- Acquire sound knowledge in Computer Science and interdisciplinary areas with Science and Technology and their applications in relevant fields with the latest technologies.
- Take up a research with proper baseline.
- Acquire strong analytical and synthesizing capability with innovative and creative thinking.

Course Titles and Syllabus

COURSE-I: RESEARCH METHODOLOGY

Course Description:

This course will provide an opportunity for students to establish or advance their understanding of research through critical exploration of research language, ethics, and approaches. The course introduces the language of research, ethical principles and challenges, and the elements of the research process within quantitative, qualitative, and mixed methods approaches. Students will use these theoretical underpinnings to begin to critically review literature relevant to their field or interests and determine how research findings are useful in forming their understanding of their work, social, local and global environment.

Course Objectives:

The course is to familiarize the students with the foundations of research which are essential in taking up any research activity.

- Understand research terminology
- Be aware of the ethical principles of research, ethical challenges and approval processes
- Describe quantitative, qualitative and mixed methods approaches to research

Course content:

Advanced Algorithms: Complexity Issues, P vs NP, Nondeterministic Problem Reduction, Approximation Algorithms, Data: Types of Data, Clustering, Normalization, Strategies of Clustering, Reduction of Dimension, Graph Slicing, Research: Overview, Hypothesis, Research Categories, Research Process, Documentation, Paper Publications, Thesis Writing, Research Discussions (Seminars, Conferences, Symposiums, Workshops). Theory of science; research problems and strategies in special needs education. Qualitative and quantitative research designs, methods, instruments, data analysis and presentation. Research ethics. Principles and techniques of statistical analysis. Conceptualizing and conducting a research proposal. The course is an obligatory component in the third semester of the two-year Master of Philosophy in Special Needs Education Programme.

Course Outcomes:

Upon completing this course, each student will be able to:

- Demonstrate knowledge of research processes (reading, evaluating, and developing);
- Employ American Psychological Association (APA) formats for citations of print and electronic materials;
- Identify, explain, compare, and prepare the key elements of a research proposal/report;
- Define and develop a possible HIED research interest area using specific research designs;
- Compare and contrast quantitative and qualitative research paradigms, and explain the use of each in HIED research;
- Describe, compare, and contrast descriptive and inferential statistics, and provide examples of their use in HIED research;
- Describe sampling methods, measurement scales and instruments, and appropriate uses of each;
- Explain the rationale for research ethics, and the importance of and local processes for Institutional Review Board (IRB) review;
- Demonstrate how educational research contributes to the objectives of your doctoral program and to your specific career aspirations in HIED.

References:

1. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran-Computer Algorithms**,** Silicon Press, 2008.
2. Jean-Paul Tremblay, P. G. Sorenson **–** An introduction to data structures with applications, McGraw-Hill.
3. Horowitz Ellis Sahni Sartaj & Anderson-Freed Susan Fundamentals of Data Structures In C (Pul), Orient Black Swan.
4. Anil K Jain, R. C. Dubes: Algorithms for Clustering Data.
5. Anil K Jain, M. N. Murthy and P. J. Flynn: Data Clustering-A Review.
6. Related Research papers.

COURSE-II: ADVANCED COMPUTATIONAL MATHEMATICS

Course Description:

The aim of the four-semester Master's programme "Advanced and Computational Mathematics" is to train highly qualified graduates in mathematics who are capable of successfully dealing with challenges encountered in academic and practical working fields. Based on a Bachelor's degree in mathematics, the programme deepens knowledge and skills in pure and applied mathematics. The following three main fields of specialization are offered:

- Advanced Theoretical Mathematics
- Computational Mathematics
- Data Sciences

The programme also covers basic education in a non-mathematical minor chosen by the student from one of the faculties of Mechanical Engineering, Electrical Engineering and Information Technology, Computer Science, or Economics and Business Administration. Upon completion of the Master's degree, particularly qualified students can enter directly into the PhD programme.

The PhD study programme deepens knowledge and skills, especially for independent scientific work. In addition to immersion in the field of specialization, students have the option to attend lectures and seminars on the latest research and to discuss current problems in research.

Course Objectives:

The main objective of this program is to produce skilled applied mathematicians, well prepared for advanced industrial positions or continued graduate studies.

Course content:

Linear Algebra: Linear transformation, vector spaces, hash function, Hermite polynomial, Heavisite's unit function and error function. Elementary concepts of Modular mathematics, Solution of Partial Differential Equation (PDE) by separation of variable method, numerical solution of PDE (Laplace, Poisson's, Parabolic) using finite difference methods, Elementary properties of FT, DFT, WFT, Wavelet transform, Haar transform, Probability, compound probability and discrete random variable. Binomial, Normal and Poisson's distributions, Sampling distribution, elementary concept of estimation and theory of hypothesis, recurred relations, Stochastic process, Markov process transition probability transition probability matrix, just and higher order Markov process, Application of Eigen value problems in Markov Process, Markov chain. Queuing system, transient and steady state, traffic intensity, distribution queuing system, concepts of queuing models (M/M/1: Infinity/ Infinity/ FC FS), (M/M/1: N/ Infinity/ FC FS), (M/M/S: Infinity/ Infinity/ FC FS) , Operations of fuzzy sets, fuzzy arithmetic & relations, fuzzy relation equations, fuzzy logics. MATLAB introduction, programming in MATLAB scripts, functions and their application.

Learning Outcomes:

A Master of Philosophy in Applied and Computational Mathematics will be able to:

Formulate mathematical models, choose suitable methods to investigate those models including the efficient use of computer tools, analyze different mathematical models within science and technology and work creatively, systematically and critically, work out solution strategies to important classes of mathematical problems, knowing the capabilities and limitations of different methods and tools, work efficiently in a teamwork environment, communicate results and conclusions in a competent and intelligible manner, both orally and in writing, with management, experts, and society at large, follow and participate in research and development related to the chosen specialization.

References:

- Higher Engineering Mathematics by B.V. Ramana, Tata Mc Hill.
- Advance Engineering Mathematics by Ervin Kreszig, Wiley Easten Edd.
- Applied Numerical Methods with MATLAB by Steven C Chapra, TMH.
- Advance Engg Mathematics, O' Neil, Cengage (Thomson) 4. Introductory Methods of Numerical Analysis by S.S. Shastry,
- Introduction of Numerical Analysis by Forberg
- Numerical Solution of Differential Equation by M. K. Jain
- Numerical Mathematical Analysis By James B. Scarborogh
- Fourier Transforms by J. N. Sheddon
- Fuzzy Logic in Engineering by T. J. Ross
- Fuzzy Sets Theory & its Applications by H. J. Zimmersoms

COURSE-III: COMPUTER VISION

Course Description:

This course provides an introduction to computer vision including fundamentals of image formation, camera imaging geometry, feature detection and matching, stereo, motion estimation and tracking, image classification and scene understanding. We'll develop basic methods for applications that include finding known models in images, depth recovery from stereo, camera calibration, image stabilization, automated alignment, tracking, boundary detection, and recognition. The focus of the course is to develop the intuitions and mathematics of the methods in lecture, and then to learn about the difference between theory and practice in the projects.

Course Objectives:

- Recognize and describe both the theoretical and practical aspects of computing with images. Connect issues from Computer Vision to Human Vision
- Describe the foundation of image formation and image analysis. Understand the basics of 2D and 3D Computer Vision.
- Become familiar with the major technical approaches involved in computer vision. Describe various methods used for registration, alignment, and matching in images.
- Get an exposure to advanced concepts leading to object and scene categorization from images.
- Build computer vision applications.

Course content:

Image Formation Models: Monocular imaging system, Orthographic& Perspective Projection, Camera model and Camera calibration, Binocular imaging systems. Image Processing and Feature Extraction : Image representations (continuous and discrete), Edge detection.

Motion Estimation : Regularization theory, Optical computation, Stereo Vision, Motion estimation, Structure from motion. Shape Representation and

Segmentation : Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet descriptors, Medialrepresentations, Multiresolution analysi. Object recognition:Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal Component analysis, Shape priors for recognition.

Learning Outcomes:

After completing the course students will be able to:

- Identify basic concepts, terminology, theories, models and methods in the field of computer vision.
- Describe known principles of human visual system.
- Describe basic methods of computer vision related to multi-scale representation, edge detection and detection of other primitives, stereo, motion and object recognition.
- Suggest a design of a computer vision system for a specific problem

References

1. Richard Szeliksy **"**Computer Vision: Algorithms and Applications**"** (http://szeliski.org/Book/)
2. Haralick& Shapiro, **"**Computer and Robot Vision**"**, Vol II
3. G_erardMedioni and Sing Bing Kang **"**Emerging topics in computer vision**"**
4. Emanuele Trucco and AllessandroVerri **"**Introductory Techniques for 3-D Computer Vision**"**, Prentice Hall, 1998.
5. Olivier Faugeras, **"**Three-Dimensional Computer Vision**"**, The MIT Press, 1993.

COURSE-IV: DATA CLUSTERING

Course Description:

Methods, describing key techniques commonly used for clustering, such as feature selection, agglomerative clustering, partitional clustering, density-based clustering, probabilistic clustering, grid-based clustering, spectral clustering, and nonnegative matrix factorization. Domains, covering methods used for different domains of data, such as categorical data, text data, multimedia data, graph data, biological data, stream data, uncertain data, time series clustering, high-dimensional clustering, and big data. Variations and Insights, discussing important variations of the clustering process, such as semi supervised clustering, interactive clustering, multiview clustering, cluster ensembles, and cluster validation

Course Objectives:

- Discover structures and patterns in high-dimensional data.
- Group data with similar patterns together.
- This reduces the complexity and facilitates interpretation.

Course Content:

Cluster Analysis Introduction: Types of data in Cluster Analysis, A Categorization of Major Clustering Methods, Partitioning Methods, Density-Based Methods, Grid-Based Methods, Model-Based Methods, Clustering high dimensional data, Constraint Based cluster analysis, Outlier Analysis. Estimation, prediction, and classification algorithms, including k-means clustering, BIRCH clustering, divisive; agglomerative, monthetic, polythetic, and distance. The difference between a hierarchical and a non-hierarchical classification. Choose an appropriate distance measure. Measuring distance.
The differences between cluster algorithms based on averages, distances, similarity and variance.

Learning Outcomes:

On completion of this lesson the student shall be able to (Outcomes)

- Understand and apply a wide range of clustering, estimation, prediction, and classification algorithms, including k-means clustering, BIRCH clustering
- Define the following terms: divisive; agglomerative, monthetic, polythetic, distance.
- Explain the difference between a hierarchical and a non-hierarchical classification.
- Choose an appropriate distance measure.
- Decide if data should be standardized before measuring distance.
- Explain the differences between cluster algorithms based on averages, distances, similarity and variance.
- Interpret the relationships between cases from a dendrogram.
- Judge the quality of a classification.
- Select alternative clustering solutions that are likely to improve the usefulness of an analysis.

References:

1. Kaufman, L., & Rousseeuw, P. J. (2005). Finding Groups in Data. An Introduction to Cluster Analysis (p. 342). John Wiley & Sons Inc.
2. Maechler, M. (2013). Cluster Analysis Extended Rousseeuw et al. CRAN.

COURSE-V: DIGITAL SIGNAL PROCESSING

Course Description:

Digital Signal Processing (DSP) is concerned with the representation, transformation and manipulation of signals on a computer. After half a century advances, DSP has become an important field, and has penetrated a wide range of application systems, such as consumer electronics, digital communications, medical imaging and so on. With the dramatic increase of the processing capability of signal processing microprocessors, it is the expectation that the importance and role of DSP is to accelerate and expand. Discrete-Time Signal Processing is a general term including DSP as a special case. This course will introduce the basic concepts and techniques for processing discrete-time signal on a computer. By the end of this course, the students should be able to understand the most important principles in DSP. The course emphasizes understanding and implementations of theoretical concepts, methods and algorithms.

Course Objectives:

- To give the students a comprehension of the concepts of discrete-time signals and systems
- To give the students a comprehension of the Z- and the Fourier transform and their inverse
- To give the students a comprehension of the relation between digital filters, difference equations and system functions
- To give the students knowledge about the most important issues in sampling and reconstruction to make the students able to apply digital filters according to known filter specifications
- To provide the knowledge about the principles behind the discrete Fourier transform (DFT) and its fast computation
- To make the students able to apply Fourier analysis of stochastic signals using the DFT
- To be able to apply the MATLAB programme to digital processing problems and presentations

Course content:

Basic elements of DSP – concepts of frequency in Analog and Digital Signals – sampling theorem – Discrete – time signals, systems – Analysis of discrete time LTI systems – Z transform – Convolution – Correlation.

Introduction to DFT – Properties of DFT – Circular Convolution - Filtering methods based on DFT – FFT Algorithms - Decimation – in – time Algorithms, Decimation – in – frequency Algorithms – Use of FFT in Linear Filtering – DCT – Use and Application of DCT.

Structures of IIR – Analog filter design – Discrete time IIR filter from analog filter – IIR filter design by Impulse Invariance, Bilinear transformation, Approximation of derivatives – (LPF, HPF, BPF, BRF) filter design using frequency translation.

Structures of FIR – Linear phase FIR filter techniques (Rectangular Window, Hamming techniques.

Learning Outcomes:

- ineering problems in terms of DSP tasks
- Analyze digital and analog signals and systems
- Analyze discrete time signals in frequency domain
- Design digital filters
- Change sampling rate of the signal
- Conceptualize the need of adaptive filters in communication applications.
- Understand the key Architectural features of Digital Signal Processor
- Apply digital signal processing algorithms to various areas

References

1. Steven W. Smith, “The Scientist and Engineer's Guide to Digital Signal Processing”, California Technical Publishing, 1997, ISBN 0-9660176-3-3. http://www.dspguide.com/pdfbook.htm (You can download the entire book!)
2. Kermit Sigmon, "Matlab Primer", Third Edition, Department of Mathematics, University of Florida.
3. V.K. Ingle and J.G. Proakis, "Digital Signal Processing using MATLAB", Bookware Companion Series, 2000, ISBN 0-534-37174-4.

COURSE-VI: DOCUMENT ANALYSIS AND ECOGNITION

Course Description:

Processing of semi-structured documents such as internet pages, RSS feeds and their accompanying news items, and PDF brochures is considered from the perspective of interpreting the content. This course considers the \document" and it's various genres as a fundamental object for business, government and community. For this, the course covers four broad areas: (A) information retrieval, (B) natural language processing, (C) machine learning for documents, and (D) relevant tools for the Web. Basic tasks here are covered including content collection and extraction, formal and informal natural language processing, information extraction, information retrieval, classification and analysis. Fundamental probabilistic techniques for performing these tasks and some common software systems will be covered, though no area will be covered in any depth.

Course Objectives:

Document Analysis and Recognition (DAR) aims at the automatic extraction of information presented on paper and initially addressed to human comprehension. The desired output of DAR systems is usually in a suitable symbolic representation that can subsequently be processed by computers.

Course content:

Most of the data we interact with day-to-day does not come in the form of data structures or databases, but instead in the form of documents and document images. This course introduces students to the formats, techniques, and algorithms used for representing, compressing, analyzing, processing, and displaying documents. Topics covered include: document formats and standards (TIFF, JPEG, PDF, PostScript, SVG). Document image compression (G4, MRC, token based compression, JPEG2000). Logical markup (HTML, XML, word processing formats, DocBook). Writings systems of the world. Character sets and character encodings (ASCII, Unicode, special coding systems). Text rendering, layout, ligatures, and hyphenation (Pango). Typesetting and page layout systems (text flow, Word, LaTeX, etc.). OCR (character recognition, page segmentation). Spelling and orthographic variation, statistical language modeling. Document capture, page image dwarfing and handheld document capture. Named entity recognition, information extraction, and table recognition. Document search and retrieval, text mining, document databases. Reading, psychophysics, and human-document interaction. Document security and forensics

Learning Outcomes:

Upon successful completion, students will have the knowledge and skills to:

Upon successful completion of the course, the student will have an understanding of the role documents play in business and community, and the various digital resources available for document analysis. Moreover, the student will have the background theory and practical knowledge necessary to plan and execute a basic document analysis project. The student will be able to:

Differentiate between the basic probabilistic theories of language and document structure, information retrieval, and classification, clustering and document feature engineering.

- Identify the basic algorithms and software available for probabilistic theories of language and be proficient at using common libraries for natural language processing to perform basic analysis tasks.
- Index a document collection for use in an information retrieval system. Demonstrate advanced knowledge of basic theories and algorithms to determine large scale named-entity matching and standardization of names within a collection.
- Perform automated classification using probabilistic theories.

References:

1. Introduction to Information Retrieval, C.D. Manning, P. Raghavan and H. Scutze, Cambridge University Press, 2008.
2. Foundations of Statistical Natural Language Processing, C.D. Manning and H. Scutze, MIT Press, 1999.

COURSE-VII: GAME THEORY

Course Description:

The main goal of the course is to introduce students to the basic concepts and tools of game theory and to apply these tools to real-life situations. Students will learn the fundamentals of game theory starting with basic terms such as strategies, payoffs, and information, and then will progress from the analysis of simple to more complex games. These will include single-move games, games with multiple rounds, games played with complete knowledge and those where information is imperfect, and games with just two players to those with multiple players.

Course Objectives:

Define the basics of a "game". Translate the basic of a "game" into a wide range of conflicts. Analyze conflict dynamics from the standpoint of rationality. Evaluate conflict dynamics from the standpoint of the self interests of the "Players". Integrate increasing analytical skills into increasingly complex conflicts. Theorize possible and probable strategies where information is incomplete. Appraise theoretical predictions obtained from Game Theory analyses against real world conflicts. Formulate strategic alternatives which take into account the actions of others (commonly known as a "Nash Equilibrium"). Identify Nash Equilibria in various everyday settings. Recognize the classic "Prisoners' Dilemma"

Course content:

Basic framework: games and decisions, Zero-sum games: secure strategy, minmax theorem, value of a game, Normal form games: dominance, iterated dominance, Nash equilibrium, Extensive form games: subgame perfection, sequential equilibrium, Bargaining: Rubinstein bargaining, Nash bargaining, Repeated games: Folk theorem and repeated prisoner's dilemma, Incomplete information games: Bayesian equilibrium, higher order beliefs, Auctions and mechanism design: Basic auctions, VCR mechanisms

Learning Outcomes:

On successful completion of this course, students will be able to:

- Identify strategic situations and represent them as games
- Solve simple games using various techniques
- Analyse economic situations using game theoretic techniques
- Recommend and prescribe which strategies to implement

References:

1. Eichberger, J. (1993). Game Theory for Economists, Academic Press, San Diego.
2. Fudenberg, D., Tirole, J. (1991). Game Theory, MIT Press, Cambridge, Massachussets.
3. Osborne, M., Rubinstein, A. (1994). A Course in Game Theory, MIT Press, Cambridge, Massachussets. Mas-Collel, A., Whinston, M. D., Green, J. R. (1995). Microeconomic Theory, Oxford University Press, New York, Oxford. (Chapters 13, 14)

COURSE-VIII: MACHINE LEARNING

Course Description:

Machine learning uses interdisciplinary techniques such as statistics, linear algebra, optimization, and computer science to create automated systems that can sift through large volumes of data at high speed to make predictions or decisions without human intervention. Machine learning as a field is now incredibly pervasive, with applications spanning from business intelligence to homeland security, from analyzing biochemical interactions to structural monitoring of aging bridges, and from emissions to astrophysics, etc. This class will familiarize students with a broad cross-section of models and algorithms for machine learning, and prepare students for research or industry application of machine learning techniques.

Course Objectives:

- To introduce students to the basic concepts and techniques of Machine Learning.
- To develop skills of using recent machine learning software for solving practical problems.
- To gain experience of doing independent study and research.

Course content:

Introduction in Machine Learning, Statistical Foundations, Decision Tree learning, Artificial Neural Networks, Support Vector Machines, Bayesian Learning, Instance based learning, Unsupervised learning, Reinforcement Learning

Learning Outcomes:

By the end of the course, students should be able to:

- Develop an appreciation for what is involved in learning models from data.
- Understand a wide variety of learning algorithms.
- Understand how to evaluate models generated from data.
- Apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.

Reference:

1. Ethem Alpaydin, Introduction to Machine Learning, Second Edition
2. Stephen Marsland, Machine Learning: An Algorithmic Perspective.
3. Christopher M. Bishop, Pattern Recognition and Machine Learning.
4. Tom Mitchell, Machine Learning, http://www.cs.cmu.edu/~tom/mlbook.html

COURSE-IX: MULTIMEDIA DATA ARCHIVAL AND RETRIEVAL SYSTEMS

Course Description:

Basic concepts for multimedia application and research , Multimedia data types and formats, Multimedia indexing and retrieval. Media representation for video. Frame/Shot Detection, Event Detection. Video segmentation and video summarization. Video Indexing, MPEG-7. Extraction of low-and high-level features. Integration of features and efficient similarity comparison.

Course Objectives:

On successful completion of this subject, students will: understand fundamental concepts, theory and techniques, multimedia content description multimedia database indexing, browsing and retrieval be familiar with applications of multimedia systems and their implementations, gain skills and knowledge beneficial to future work and post-graduate study in multimedia area.

Course Content:

Basic characteristics of multimedia databases. Evaluation of retrieval effectiveness, Precision-Recall Analysis. Semantic content of image-content search. Image representation, low-level and high-level features. Texture features, random-field models. Audio formats, sampling, metadata. Thematic search within music tracks. Query formulation in music databases. Media representation for video. Frame/Shot Detection, Event Detection. Video segmentation and video summarization. Video Indexing, MPEG-7. Extraction of low-and high-level features. Integration of features and efficient similarity comparison. Indexing over inverted file index, indexing Gemini, R *- trees

Learning Outcomes:

1. Developed understanding of technical aspect of Multimedia Systems.
2. Understand various file formats for audio, video and text media.
3. Develop various Multimedia Systems applicable in real time.
4. Design interactive multimedia software.
5. Apply various networking protocols for multimedia applications.
6. To evaluate multimedia application for its optimum performance.

References:

1. Multimedia database management systems --Guojin Lu. Publication Details Boston, MA : Artech House, 1999.

2. Introduction to MPEG-7 : multimedia content description interface -- edited by B.S. Manjunath, Phillipe Salembier, Thomas Sikora. z Publication Details Chichester ; Milton (Qld.): Wiley, 2002.

3. Multimedia information retrieval and management : technological fundamentals and applications / David Dagan Feng, Wan-Chi Siu, Hong-Jiang Zhang (eds.). Publication Details Berlin ; New York : Springer, 2003.

4. Digital Image Processing -- Rafeal Gonzalez

COURSE-X: MULTIMEDIA SYSTEMS

Course Description:

This is an introductory course in digital media. It is intended for students from all backgrounds who are interested in learning the foundational scientific concepts and the basic techniques of digital media production. Knowing about the connection between scientific concepts and applications will help you in making educated guesses, rather than relying on defaults or recipes, in using tools and techniques in application programs. The practical component of the course is organized around learning about, and using various software's for manipulating digital sound, digital images, and digital video.

Course Objectives:

Multimedia has become an indispensable part of modern computer technology. In this course, students will be introduced to principles and current technologies of multimedia systems. Issues in effectively representing, processing, and retrieving multimedia data such as sound and music, graphics, image and video will be addressed. The students will gain hands-on experience in those areas by implementing some components of a multimedia streaming system as their term project. Latest Web technologies and some advanced topics in current multimedia research will also be discussed.

Course Content:

Overview of multimedia systems and applications, Digitization: sampling, quantization, Nyquist theorem, Digital audio: sounds, speech and music, audio effects, MIDI, Digital imaging: resolution, file formats, color representation, Analog and digital video, Basic sound, image and video editing, Animation, Data compression techniques.

Learning Outcomes:

- To acquire fundamentals principles of multimedia, including digitization and data.
- Compression for non-textual information to understand issues in representing, processing, and transmitting multimedia data.
- To understand core multimedia technologies and standards.
- To gain hands-on experience in image, sound and video editing and in some aspects of multimedia authoring (incorporating images, sound, video, and animation)
- To design, capture, store and integrate sound, images and video to deliver multimodal information.

References:

1. Burg, J. (2009). The science of digital media. Prentice Hall, Upper Saddle River: NJ. - Chapters 1, 2, 4 and 6.
2. Ze-Nian, L. & Drew, M.S. (2004). Fundamentals of Multimedia. Prentice Hall, Upper Saddle River, NJ. - Parts I and II

COURSE-XI: PARALLEL COMPUTING ALGORITHMS

Course Description:

Parallel computing is pervasive. From embedded devices, laptops, to high-end supercomputer, and large-scale data centers, parallel computing is widely employed to achieve performance and efficiency targets. This course introduces the foundations of parallel computing, including parallel architectures, parallel programming methods and techniques, parallel algorithm designs, and parallel performance analysis.

Course Objectives:

This course is an introduction to parallel computing and aims at teaching basic models of parallel machines and tools to program them. It is an introduction to parallel programming, how to parallelize programs, and how to use basic tools like MPI and POSIX threads.

- Parallel Programming Platforms.
- Principles of Parallel Algorithm Design.
- Analytical Modeling of Parallel Programs.
- Parallel Programming Paradigms.
- Programming Shared Address Space Platforms.
- Programming Message Passing Platforms.
- pthreads.

Course content:

Parallel Computers, Message-Passing Computing, Embarrassingly Parallel Computations, Partitioning and Divide-and-Conquer Strategies, Pipelined Computations, Synchronous Computations , Load Balancing and Termination Detection , Programming with Shared Memory, Distributed Shared Memory Systems and Programming, Sorting Algorithms, Numerical Algorithms, Image Processing, Searching and Optimization

Learning Outcomes:

At the end of this course, student should be able to accomplish the objectives given below.

- Define terminology commonly used in parallel computing, such s efficiency and speedup.
- Describe different parallel architectures; inter-connect networks, programming models, and algorithms for common operations such as matrix-vector multiplication.
- Given a problem, develop an efficient parallel algorithm to solve it.
- Given a parallel algorithm, analyze its time complexity as a function of the problem size and number of processors.
- Given a parallel algorithm, an input to it, and the number of processors, show the steps performed by that algorithm on that input.
- Given a parallel algorithm, implement it using MPI, OpenMP, pthreads, or a combination of MPI and OpenMP.
- Given a parallel code, analyze its performance, determine computational bottlenecks, and optimize the performance of the code.
- Given a parallel code, debug it and fix the errors.
- Given a problem, implement an efficient and correct code to solve it, analyze its performance, and give convincing written and oral presentations explaining your achievements.

References:

1. Michael J Quinn, Parallel Computing, TMH
2. Joseph Jaja, An Introduction to Parallel Algorithms, Addison Wesley
3. Parallel Programming in C with MPI and OpenMP by M.J. Quinn, McGraw-Hill

COURSE-XII: PATTERN RECOGNITION AND NEURAL NETWORKS

Course Description:

This is a first level graduate course on Machine Learning (ML). The emphasis in the course is on supervised classification models. While students need not have any prior exposure to ML, they should have good familiarity with probability theory at the level of joint distribution of several random variables, expectation, conditional expectation, basics of stochastic convergence, and basics of stochastic processes. All first year MPhil and Ph.D. students, who had a prior course on Prabability and random processes, can take this course. The course involves some programming assignments which are mostly about learning pattern classifiers on different data sets supplied to them using different methods. Some exposure to ML software tools in Python would be provided during the course.

Course Objectives:

In this course, we will study the following topics:

- Basic neuron models: McCulloch-Pitts model and the generalized one, distance or similarity based neuron model, radial basis function model, etc.
- Basic neural network models: multilayer perceptron, distance or similarity based neural networks, associative memory and self-organizing feature map, radial basis function based multilayer perceptron, neural network decision trees, etc.

- Basic learning algorithms: the delta learning rule, the back propagation algorithm, self-organization learning, the r4-rule, etc.
- Applications: pattern recognition, function approximation, information visualization, etc.

Course content:

Introduction to pattern recognition, Bayesian decision theory, supervised learning from data, parametric and non parametric estimation of density functions, Bayes and nearest neighbor classifiers, introduction to Page 1/2 statistical learning theory, empirical risk minimization, discriminant functions, learning linear discriminant functions, Perceptron, linear least squares regression, LMS algorithm, artificial neural networks for pattern classification and function learning, multilayer feed forward networks, backpropagation, RBF networks, deep neural Networks, CNNs, Autoencoders, RBMs, support vector machines, kernel based methods, feature selection and dimensionality reduction methods.

Learning Outcomes:

The course equips the students with strong basics in Machine Learning (ML). The students would study different algorithms for learning pattern classifiers and would also explore different datasets to get a feel for ML algorithms. The statistical and/or optimization principles underlying different algorithms would be emphasized and thus the students would pick up the background needed to study more advanced topics in ML. The course would be useful both for students wanting to build a career in industry using ML as well as for students wanting to pursue research in ML.

References:

1. R.O.Duda,P.E.Hart and D.G.Stork,Pattern Classification, John Wiley, 2002.
2. C.M.Bishop, Neural Networks and Pattern Recognition, Oxford University Press (Indian Edition), 2003.
3. Dudo R O, Hart P E & Stork D G, Pattern Classification John Wiley & sons, 2002.,
4. Bishop C M, Pattern Recognition and Machine learning, Springer, 2006 some course notes that would be supplied and some papers from current literature.

COURSE-XIII: SOFT COMPUTING STRATEGIES

Course Description:

Soft computing is an emerging approach to computing which parallel the remarkable ability of the human mind to reason and learn in an environment of uncertainty and imprecision. Soft computing is based on some biological inspired methodologies such as genetics, evolution, ant's behaviors, particles swarming, human nervous systems, etc. Now, soft computing is the only solution when we don't have any mathematical modeling of problem solving (i.e., algorithm), need a solution to a complex problem in real time, easy to adapt with changed scenario and can be implemented with parallel computing. It has enormous applications in many application areas such as medical diagnosis, computer vision, hand written character recondition, pattern recognition, machine intelligence, weather forecasting, network optimization, VLSI design, etc.

Course Objectives:

The main objective of the course is to expose the students to soft computing, various types of soft computing techniques, and applications of soft computing. .Upon completion of this course, the student should be able to get an idea on :

- Artificial Intelligence, Various types of production systems, characteristics of production systems.
- Neural Networks, architecture, functions and various algorithms involved.
- Fuzzy Logic, Various fuzzy systems and their functions.
- Genetic algorithms, its applications and advances.

Course content:

Soft Computing: Introduction to soft computing, soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing. Artificial Intelligence: Introduction, Various types of production systems, characteristics of production systems, breadth first search, depth first search techniques, other Search Techniques like hill Climbing, Best first Search, A* algorithm, AO* Algorithms and various types of control strategies. Knowledge representation issues, Prepositional and predicate logic, monotonic and non monotonic reasoning, forward Reasoning, backward reasoning, Weak & Strong Slot & filler structures, NLP. Neural Network: Structure and Function of a single neuron: Biological neuron, artificial neuron, definition of ANN, Taxonomy of neural net, Difference b/w ANN and human brain, characteristic and applications of ANN, single layer network. Perceptron: Perceptron training algorithm, Linear separability , Widrow & Hebb's learning rule/Delta rule, ADALINE, MADALINE, AI v/s ANN. Introduction of MLP, different activation functions, Error back propagation algorithm, derivation of BBPA, momentum, limitation, characteristics and application of EBPA. Counter propagation network: architecture , functioning & characteristics of counter Propagation network, Hop field/ Recurrent network, configuration, stability constraints, associative memory, and characteristics, limitations and applications. Hopfield v/s Boltzman machine. Adaptive Resonance Theory: Architecture, classifications, Implementation and training. Associative Memory. Fuzzy Logic: Fuzzy set theory, Fuzzy set versus crisp set, Crisp relation & fuzzy relations, Fuzzy systems: crisp logic, fuzzy logic, introduction & features of membership functions. Fuzzy rule base system : Fuzzy propositions, formation, decomposition & aggregation of fuzzy Rules, fuzzy reasoning, fuzzy inference systems, fuzzy decision making & Applications of fuzzy logic. Genetic algorithm: Fundamental, basic concepts, working principle, encoding, fitness function, reproduction, Genetic modeling: Inheritance operator, cross over, inversion

& deletion, mutation operator, Bitwise operator ,Generational Cycle, Convergence of GA, Applications & advances in GA, Differences & similarities between GA & other traditional methods.

Learning Outcomes:

At the end of the course the student should be able to

- Learn about soft computing techniques and their applications
- Analyze various neural network architectures
- Understand perceptrons and counter propagation networks.
- Define the fuzzy systems
- Analyze the genetic algorithms and their applications.

References:

1. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI. Genetic Algorithms: Search and Optimization, E. Goldberg.
2. Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee, PHI.
3. Build_Neural_Network_With_MS_Excel_sample by Joe choong.