DEPARTMENT OF COMPUTER SCIENCE
M. PHIL COMPUTER SCIENCE - GUIDE PAPER SYLLABUS
2019-2020

19URCSC0E01 ADVANCED MOBILE COMPUTING

Course Objectives:

- To introduce the Advancement of Mobile Computing and look at current trends.
- To study the various approaches in Mobile Ad hoc security.
- To study on Theory Research in Seamless Mobility.
- Examine Systems Research in Seamless Mobility.

UNIT 1: Introduction

Wireless transmission – Frequencies for radio transmission– Signals -–Antennas - Signal propagation: Path loss of radio signals - Additional signal propagation effects - Multi-path propagation – Multiplexing - Modulation-Spread spectrum - SDMA-FDMA-TDMA-CDMA-GSM System Architecture-Handover-Security.

UNIT 2: Mobile Systems

Satellite Systems: Applications – Basics – Routing – Localization – Handover - WLAN-IEEE802.11: System Architecture- Mobile IP: Goals, assumptions and requirements – entities and terminology – packet delivery – Agent discovery – Registration – Tunneling and encapsulation Recent technologies

UNIT 3: MANET Security

Security in Wireless Ad Hoc Networks – Intrusion Detection in Mobile Ad Hoc Networks – Security Threads in Ad Hoc Routing Protocols – Trust Management in Mobile Ad hoc Networks.

UNIT 4: SEAMLESS MOBILITY

Integration of Heterogeneous Wireless Access Networks – Network Selection for Heterogeneous Wireless Access Networks – Modeling and performance analysis of Voice Admission Control in Next Generation Heterogeneous Mobile Networks – Energy Saving aspects for Mobile Device Exploiting Heterogeneous Wireless Networks.

UNIT 5: RESEARCH ON SEAMLESS MOBILITY

A Comprehensive approach to Vertical handoff in heterogeneous wireless networks - The Seamless mobility of heterogeneous networks based on the Markov decision process-A Reliable Seamless Handoff scheme based on Enhanced MADM methods –-PROMETHEE and AHP: Then Design of Operational Synergies in Multicriteria Analysis - Vertical Handover Analysis Using Modified MADM Method in LTE.

Reference Books:

1. Jochen Schiller, "Mobile Communication" ,Pearson Education, Second Edition, 2009.
2. Sudip Misra etl., "Guide to Wireless Ad Hoc Networks", Springer International Edition, 2009.
3. Ekram Hossain, "Heterogeneous Wireless Access Networks: Architecture and Protocols, Springer, 2008.
4. Stefano Basagni and et.al., "Mobile Ad Hoc Networking: Cutting Edge Directions", IEEE Press, WILEY Publications, 2013

Course outcomes:

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

- Understand the Advanced Mobile Computing research in Seamless Mobility and MANET Security.
- Develop Seamless Mobility of Heterogeneous networks based on various methods for real time applications.

19URCSC0E02 COMPUTER VISION TECHNIQUES

Course Objectives:

- To provide complete knowledge on Computer Vision Techniques, such as Image formation models, Edge detection, Shape Segmentation, 2D and 3D Vision Formation, Feature Extraction and Motion Estimation, Morphological concepts and basic understanding of Computer Vision concepts,.
- To understand these concepts and implement them empirically.

UNIT I

Introduction: What is Computer vision - Difference between Computer Vision and Image Processing - Low – level, Middle- level, High level - Overview of Diverse computer vision applications: Document Image Analysis, Biometrics, Object Recognition, Object Tracking, Medical Image Analysis, Content-Based image retrieval, Video Data Processing,Multimedia, Virtual Reality and Augmented Reality.

UNIT II

Image Formation Models: Intensity Images - Image Focusing- Thin Lenses-Aberrations-Geometric Image Formation-Photometric Image Formation-Diffuse Component-Specular Component-Ambient Component-Complete Shading Model-Camera model and camera calibration - Binocular imaging system - Multiple views geometry - Geometric Primitives - Structure determination - Shape from shading.

UNIT III

Feature Extraction and Segmentation: Edge detection -Corner and Interest Point Detection - Mathematical Morphology: Dilation and Erosion–Texture - Segmentation: Contour and Region, Deformable Curves and Surfaces, Snakes and Active Contours – Split and Merge - Mean shift and mode finding - Normalized cuts - Graph cuts and energy-based methods.

UNIT IV

2D and 3D Vision Formation: Human Visual System - Stereoscopic Acquisition Systems - Scale-space Vision - The Three-Dimensional World - Horaud’s Junction Orientation Technique - Tackling the Perspective n-point Problem - Obtaining Unique Solutions to the Pose Problem - Invariants and Perspective:Differential and Semi-differential Invariants - Vanishing Point Detection.

UNIT V

Applications: Application of Circular Convolution - 2D Correlation – Comparison of different image transforms – Zooming Operations - Zooming through Linear Interpolation – Performance Metrics in Image Restoration –Pseudo Color – Color Image Segmentation.

Reference Books:

1. D. Forsyth and J. Ponce ,Computer Vision - A modern approach, Prentice Hall Robot Vision, by B. K. P. Horn, McGraw-Hill, 2011.

2. Richard Szeliski, Computer Vision: Algorithms and Applications (CVAA). Springer, 2010.

3. E. R. Davies, Computer & Machine Vision, Fourth Edition, Academic Press, 2012.

4. Bogusław Cyganek and J. Paul Siebert, An Introduction to 3D Computer Vision Techniques and Algorithms, John Wiley & Sons, 2009.

5. S. Jayaraman, S. Esakkirajan, T.Veerakumar, Digital Image Processing, Tata McGraw Hill, Fourth Edition, 2011.

6. E. Trucco and A. Verri, Introductory Techniques for 3D Computer Vision, Publisher: Prentice Hal, 1998.

7. R. C. Gonzalez, R. E. Woods, Digital Image Processing, Addison Wesley Longman, Inc., 1992.

Course Outcomes:

After learning the course the students should be able to:

- To implement fundamental image processing techniques required for computer vision
- Understand Image formation process
- Extract features and segmentation from images and do analysis of images
- Generate 2D and 3D models from images
- To develop applications using computer vision techniques

19URCSC0E03 ADVANCED WIRELESS NETWORKS

Course objectives:

- To provide a deep knowledge on fundamental concepts, design issues and the advanced development in wireless networks.
- To enable the students to learn the various protocols and to implement in the various research problem

Unit - I

Introduction: Fundamentals of Wireless Communication technology – Electromagnetic Spectrum – Radio propagation mechanism – characteristics of wireless channel – Fundamentals of WLANs – Bluetooth – Cellular concept – Cellular architecture – Wireless Internet – Mobile IP

Unit - II

Ad hoc network: Introduction – MAC Protocols: Issues – Classification of MAC protocols – Contention based MAC protocols – Ad hoc Routing protocols : Efficient flooding mechanisms – Hierarchical routing protocols – Power aware routing protocols – Multicast routing protocols.

Unit – III

Mesh based Multicast routing protocols: On demand – Dynamic core based – Forwarding group – Neighbour supporting protocol – Core-assisted mesh protocol – Energy efficient multicasting protocols – Multicasting with QoS guarantees – Application dependent multicasting – Secure routing in ad hoc networks.

Unit - IV

Sensor Network: Introduction– Characteristics - Applications of Sensor Network – Issues and Challenges in designing Sensor Network – Hardware and Software – Standards -Sensor Network architecture – Classification of WSN – Protocol stack – Routing and Data dissemination - Data gathering.

Unit - V

Vehicular Ad hoc networks: Introduction – VANET Infrastructures – Architecture – Applications – Routing Protocols – Data dissemination – Bio Inspired routing protocols - Mobility model.

Reference books:

1. C.Siva Ram Murthy, B.S Manoj, "Ad hoc wireless networks – Architecture and Protocols," PHI, 2010.
2. Zun Zhang, Abbas Jamalipour, " Wireless Sensor Network – A Networking Perspective", John Wiley Publications, 2009
3. H. Hartenstein, K. Laberteaux, "VANET – Vehicular Applications and Internetworking Technologies", John Wiley publications, 2010
4. Salim Bitam, Abdelhamid Mellouk, "Bio Inspired Routing Protocols for Vehicular ad hoc networks" John Wiley – ISTE, 2014

Course Outcomes:

- Learners can able to know the features of wireless network and its technology
- Researchers can easily apply the various wireless routing protocols in the research problem

19URCSC0E04 ADVANCED DATA ANALYTICS

Course Objectives:

- To enable learners to develop expert knowledge and analytical skills in current and developing areas of analysis statistics, and machine learning
- To conduct independent research and analysis in the field of data analytics.
- To enable the learner to identify, develop and apply detailed analytical, creative, problem solving skills.

Unit I

Introduction to Big Data Analytics: Big Data Overview -State of the Practice in Analytics - Key Roles for the New Big Data Ecosystem - Examples of Big Data Analytics – Summary

Unit II

Data Analytics Lifecycle: Data Analytics Lifecycle Overview - Phase 1: Discovery - Phase 2: Data Preparation - Phase 3: Model Planning - Data Exploration and Variable Selection - Phase 4: Model Building - Phase 5: Communicate Results - Phase 6: Operationalize

Unit III

Advanced Analytics Theory and Methods: Clustering: Overview of Clustering - K-means - Additional Algorithms

Advanced Analytics Theory and Methods: Association Rules: Overview - Apriori Algorithm - Evaluation of Candidate Rules - Applications of Association Rules - An Example: Transactions in a Grocery Store - Validation and Testing – Diagnostics

Unit IV

Advanced Analytics Theory and Methods: Regression: Linear Regression -Logistic Regression - Reasons to Choose and Cautions - Additional Regression Models

Advanced Analytics Theory and Methods: Classification: Decision Trees - Naïve Bayes - Diagnostics of Classifiers - Additional Classification Methods

Unit V

Advanced Analytics Theory and Methods: Time Series Analysis: Overview of Time Series Analysis - ARIMA Model - Additional Methods

Advanced Analytics- Technology and Tools: MapReduce and Hadoop: Analytics for Unstructured Data - The Hadoop Ecosystem - NoSQL

Reference Books:

1. EMC Educational Services "Data Science & Big Data Analytics - Discovering, Analyzing, Visualizing and Presenting Data", John Wiley & Sons, Inc., 2015
2. Anil Maheshwari, " Data Analytics", McGraw Hill Education, 2017.
3. Lillian Pierson, Data Science For Dummies, 2nd Edition, For Dummies Publisher, 2015
4. Prateek Gupta,Data Science with Jupyter , BPB 1st Edition, 2019

Course Outcomes:

The learner will be able

- To design, develop and implement advanced data analytics tools for different types of data
- To develop skills of using advanced analytics theory, methods, technology and tools for solving real time problems.
- To gain experience of doing independent study and research.

19URCSC0E05 **EVOLUTIONARY COMPUTING**

Course objectives:

- Understand the underlying principles of evolutionary computation.
- Learn the theoretical foundations of evolutionary computation.
- Learn evolutionary strategies and Swarm Intelligence based algorithms such as Artificial Bee Colony Algorithm , Cuckoo Search and Bat Algorithm

Unit I

Introduction: Computation Inspired by Nature – Biological Processes – Evolution Versus Learning – Swarm Intelligence – Heuristics, Metaheuristics, and Hyper-Heuristics – optimization. **Simulated Annealing:** Introduction – Basic Simulated Annealing – Variants of Simulated Annealing.

Unit II

Evolutionary Strategies: Introduction – Basic Algorithm – Evolutionary Gradient Search and Gradient Evolution. **Parallel Evolutionary Algorithms:** Master-Slave Model – Island Model – Cellular EAs – Cooperative Co-evolution – Cloud Computing – GPU Computing.

Unit IV

Bee Metaheuristics: Introduction – Artificial Bee Colony Algorithm – Marriage in Honeybees Optimization – Bee Colony Optimization. **Bacterial Foraging Algorithm:** Introduction - Bacterial Foraging Algorithm. - Harmony Search Algorithm

Unit V

Swarm Intelligence: Glowworm-Based Optimization – Firefly Algorithm - Group Search Optimization – Shuffled Frog Leaping – Cuckoo Search – Bat Algorithm- Social Spider Optimization – Krill Herd Algorithm – Cockroach-Based Optimization

Unit V

Memetic Algorithms – Introduction – Cultural Algorithms – Tabu Search – Scatter search – **Search based on Human Behaviours** - Seeker optimization algorithm – Teaching Learning based optimization.

Reference Books:

1. Ke-Lin Du and M.N.S. Swamy, "Search and Optimization by Metaheuristics Techniques and Algorithms Inspired Nature", Birkhauser, 2016.

2. Albert Y. Zomaya, "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006.

3. Dario Floreano and Claudio Mattiussi, "Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT Press, 2010.

4. Kalyanmoy Deb , Multi-Objective Optimization using Evolutionary Algorithms , Wiley Student Edition, 2010

Course outcomes:

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

- Explain evolutionary computation techniques and methodologies set in the context of modern heuristic methods.
- Apply various evolutionary computation methods and algorithms for particular classes of problems.
- Develop evolutionary algorithms for real-world applications.

19URCSC0E06 **BIO COMPUTING**

Course objectives:

- To establish a basic understanding and appreciation of the issues and problems of computational biology.
- To provide an introduction to programming for biological data and use of a range of web-based Bio-computing utilities.
- To expose students to algorithmic thinking, Problems solving and impart moderate skills in programming.

Unit I

Introduction to Molecular Biology: DNA, RNA and protein - Genome, Chromosome, and Gene – Replication and Mutation of DNA – Central Dogma – Transcription (Prokaryotes) - Transcription (Eukaryotes) – Translation – Post translation Modification (PTM) – Population Genetics – Basic Biotechnological Tools – Restriction Enzymes – Sonication – Cloning – PCR – Brief History of Bioinformatics.

Unit II

Sequence Similarity and suffix Tree: Introduction – Global Assignment Problem – Needleman-Wunch Algorithm – Running time Issue – Space Efficiency Issue – More on Global Alignment – Local Alignment – Semi-Global Alignment – Scoring Function – Scoring function for DNA – Scoring Function for Protein. **Suffix Tree:** Introduction – Simple Applications of a Suffix Tree – Construction of a Suffix Tree – Suffix Array.

Unit III

Genome Alignment and Database Search: Introduction – Maximum Unique Match (MUM) – Mutation Sensitive Alignment – Concepts and definitions – The Idea of the Heuristic Algorithm – Experimental Results – **Database Search:** Introduction – Biological database – Database Searching – Types of Algorithms – Smith-Waterman Algorithm – FastA – BLAST – Q-gram Alignment based on Suffix Array – Locality-Sensitive Hashing.

Unit IV

Multiple Sequence Alignment and Genome Rearrangement: Introduction – Formal Definition of the Multiple Sequence Alignment Problem – Methods for Solving the MSA Problem – Dynamic Programming Method – Progressive Alignment Method. **Genome Rearrangement:** Introduction – Types of Genome Rearrangements – Computational Problems – Sorting an Unsigned Permutation by Reversals.

Unit V

Motif Finding: Introduction – Identifying Binding Regions of TFs – Motif Model – The Motif Finding Problem – Scanning for Known Problem – Statistical Approaches. **RNA Secondary Structure Prediction:** Introduction – Obtaining RNA Secondary Structure Experimentally – Structure Prediction with the Assumption That There is no pseudoknot – Nussinov Folding Algorithm. **Peptide Sequencing:** Introduction – Obtaining the Mass Spectrum of a Peptide – Modeling the Mass Spectrum of a Fragmented Peptide.

Reference books:

1. Wing-Kin Sung, "Algorithms in Bioinformatics – A Practical Introduction", CRC Press, 2010.
2. Seiffert, U. (Udo) Jain, L. C. Schweizer, P. (Patrick), "Bioinformatics using computational intelligence paradigms", Springer, 2004.
3. Kelemen, Arpad, Abraham, Ajith, Chen, Yuehui (Eds.), "Computational Intelligence in Bioinformatics", Springer, 2008.
4. Sushmita Mitra, Sujay Datta, Theodore Perkins , George Michailidis, "Introduction to Machine Learning and Bioinformatics", CRC Press, 2008.

Course outcomes:

On completion of this course, the student should be able to:

- Become an efficient and optimal analyzer of this ever-growing biological dataset and yield important knowledge to have direct consequences on the biological aspects.
- Understand the concepts of Central Dogma of Biology and DNA structure and encoding.
- Design Genome based projects by understanding the computational complexity of Bioinformatics problems and the usage of NCBI and available Bioinformatics tools.

19URCSC0E07 ADVANCED DATA MINING TECHNIQUES

Course Objectives:

- To introduce the advanced concepts of Data Mining Techniques and various Algorithms used for building models from Datasets, involve learning a collection of techniques for extracting patterns and trends.

- To deal with real time computing solutions for data intensive applications.

Unit I - Data Understanding

Concepts of Learning, Classification, and Regression: Introductory Comments - Classification

Knowledge Representation: Data Representation and their Categories: General Insights - Categories of Knowledge Representation - Granularity of Data and Knowledge Representation Schemes - Sets and Interval Analysis -Fuzzy Sets as Human-Centric Information Granules - Shadowed Sets - Rough Sets - Characterization of Knowledge Representation Schemes - Levels of Granularity and Perception Perspectives - The Concept of Granularity in Rules

Unit II - Data Preprocessing

Feature Extraction and Selection Methods: Introduction - Feature Extraction - Feature Selection

Discretization Methods: Why Discretize Data Attributes? - Unsupervised Discretization Algorithms - Supervised Discretization Algorithms

Unit III - Data Mining: Methods for Constructing Data Models

Unsupervised Learning: Clustering: From Data to Information Granules or Clusters - Categories of Clustering Algorithms - Similarity Measures- Hierarchical Clustering - Objective Function-Based Clustering – Grid-Based Clustering - Self-Organizing Feature Maps - Clustering and Vector Quantization - Cluster Validity - Random Sampling and Clustering as a Mechanism of Dealing with Large Datasets

Unsupervised Learning: Association Rules: Introduction - Association Rules and Transactional Data -Mining Single Dimensional, Single-Level Boolean Association Rules - Mining Other Types of Association Rules

Unit IV - Supervised Learning

Statistical Methods: Bayesian Methods – Regression

Decision Trees, Rule Algorithms, and Their Hybrids: What is Inductive Machine Learning? - Decision Trees - Rule Algorithms - Hybrid Algorithms

Unit V - Supervised Learning

Neural Networks: Introduction - Biological Neurons and their Models - Learning Rules - Neural Network Topologies - Radial Basis Function Neural Networks

Text Mining: Introduction - Information Retrieval Systems - Improving Information Retrieval Systems

Reference Books:

1. Krzysztof J. Cios, WitoldPedrycz, Roman W. Swiniarski and Lukasz A. Kurgan, "Data Mining A Knowledge Discovery Approach", Springer, 2007.

2. David L. Olson and DursunDelen, "Advanced Data Mining Techniques", Kindle Edition, 2008.

3. Galit Shmueli, Peter C. Bruce , Mia L. Stephens Nitin R. Patel ,Data Mining for Business Analytics: Concepts, Techniques, and Applications with JMP Pro, Wiley Publication, 2016.

4. Jiawei Han Micheline Kamber Jian Pei, Data Mining: Concepts and Techniques, 3rd Edition, 2011.

Course Outcomes:

The learner will be able

- To design, formulate, solve and implement advanced data mining techniques for building the data models
- To develop skills of using recent data mining software for solving practical problems.
- To gain experience of doing independent study and research.

19URCSC0E08 **FORENSICS COMPUTING**

Course objectives:

- To provide a deep knowledge on fundamental concepts of Computer forensics and Investigation methods.
- To provides a taster in understanding how to conduct investigations to correctly gather, analyze and present digital evidence to both business and legal audiences

Unit – I

Introduction – Types of Computer forensics – forensics skills – importance of forensics – Evidence Acquisition: Lab requirements – Laboratory layout, management and access – Extracting from device – skimmers

Unit – II

Network forensics: Log files – Traffic investigation – Router forensics: Router function – Router attack and investigation – Advanced persistent attack – Investigating network attack - Tools - Mobile forensics: Procedure for Handset evidence – Handset forensics – Flasher box

Unit – III

Website forensics: Attack indication – Type of attack – Web log – Web attack investigation – Investigating FTP servers - IIS logs - Apache logs - Windows based servers - Intrusion Detection - Security strategies - Web page defacement - Investigating static and IP address

Unit – IV

Internet forensics: Introduction – investigation steps – tracking and investigating email – online crime – capturing online communications – Application password crackers: Introduction – Password terminology – Password cracker – Password cracking methods – System password cracking – Application software password cracking – Default password Database

Unit – V

Investigations: Evidence analysis – Capturing the data image – Extracting information from Data – Passwords and Encryption – Website evidence –Document Investigation

Reference books:

1. Dr. Darren Hayes, "A Practical guide to Computer forensics investigations", Pearson Education Inc., 2015
2. M.G. Solomon, D. Barrett, N. Broom, "Computer forensics Jump start™", SYBEX Inc. 2005,
3. "Computer forensics-Investigating networks intrusions and cyber crime" Course technology, EC-Council Press, Cengage learning, 2010.

4. “Computer forensics-Investigating Hard disk, File and Operating Systems” Course technology, EC-Council Press, Cengage learning, 2010.

Course Outcomes:

- Learners can able to know the features and importance of Forensics computing.
- Researchers can easily apply the various forensics techniques in their research problem
- Students can able to recover and examines data from computers and other electronic storage devices in order to use the data as evidence in criminal prosecutions

19URCSC0E09 ADVANCED COMPUTER ALGORITHMS

Course Objectives:

- Enable students to explore advanced topics in algorithmic and complexity theory
- Engage in analysis and design of complex algorithms for real-world problems in application domains
- Learn and evaluate advanced / novel algorithm design strategies
- Understand study problems in algorithmic or complexity theory by analyzing known approaches and their limitations.

UNIT 1: Algorithms on Graphs

Minimum – coat spanning trees – Depth-first search – Biconnectivity – Depth-first search of a directed graph – Strong connectivity – Path-finding problems – A transitive closure algorithm – A shortest-path algorithm – Path problems and matrix multiplication – single-source problems – Dominators in a directed acyclic graph: putting the concepts together.

UNIT 2: Matrix Multiplication and Related Operations

Basics – Strassen's matrix-multiplication algorithm – Inversion of matrices – LUP decomposition of matrices – Applications of LUP decomposition – Boolean matrix multiplication.

UNIT 3: The Fast Fourier Transform and its Applications

The discrete Fourier transform and its inverse – The fast Fourier transform algorithm – The FFT using bit operations – Products of polynomials – The Schonhage - Strassen inter-multiplication algorithm.

UNIT 4: The Integer and Polynomial Arithmetic

The similarity between integers and polynomials – Integer multiplication and division – Polynomial multiplication and division – Modular arithmetic – Modular polynomial arithmetic and polynomial evaluation – Chinese remaindering – Chinese remaindering and interpolation of polynomials – Greatest common divisors and Euclid's algorithm – An asymptotically fast algorithm for polynomial GCD's – Integer GCD's – Chinese remaindering revisited – Sparse polynomials.

UNIT 5: Pattern-Matching Algorithms

Finite automata and regular expressions – Recognition of regular expression patterns – Recognition of substrings – Two-way deterministic pushdown automata – Position trees and substring identifiers.

Reference Books

1. Aho, Hopcroft, Ullman, "The Design and Analysis of Computer Algorithms", Addison Wesley,1998.
2. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", Second Edition Person, 2011.
3. Manas Ranjan Kabat, "Design and Analysis of Algorithms", PHI Learning, 2016.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", Third Edition, Hardcover, 2001.

Course Outcomes:

On completion of this course, the student should be able to:

- Students should develop a sound theoretical understanding of advanced algorithms and practical problem solving skills using them.
- Students should gain a good understanding on a wide range of advanced algorithmic problems, their relations and variants, and application to real-world problems.
- Students should develop basic advanced algorithm analysis skills for analyzing the approximation ratio of approximation algorithms and the probability of randomized algorithms.

19URCSC0E10 ARTIFICIAL INTELLIGENCE

Course Objectives:

- The primary objective of this course is to introduce the basic principles, techniques, and applications of Artificial Intelligence.
- To impart basic proficiency in representing difficult real life problems in a state space representation so as to solve them using AI techniques like searching and game playing.
- To introduce advanced topics of AI such as planning, Bayes networks, natural language processing, Robotics.

UNIT I

Introduction to AI: What is AI? – Foundations of AI – History of AI – The State of the art.- **Solving Problems by Searching**: Problem Solving Agents – Example Problems – Searching for Solution – Uninformed Search Strategies – Informed Search Strategies – Heuristics Functions - **Beyond Classical Search**: Local search algorithms and optimization problems – Local Search in continuous spaces - Searching with nondeterministic actions – Searching with Partial Observations.

UNIT II

Logical Agents: Knowledge based Agents – Logic – Propositional Logic – Propositional Theorem Proving – Effective Propositional model checking – Constraint Satisfaction problems (CSP): Defining CSP- Constraint Propagation – Backtracking Search for CSPs – Local Search for CSPs - **First Order Logic**: Syntax and Semantics – Using First order Logic - Knowledge Engineering - **Inference in First Order Logic**: Unification and Lifting – Forward Chaining – Backward Chaining – Resolution. -**Classical Planning**: Algorithms for Planning as State Space Search – Planning Graphs.

UNIT III

Knowledge Representation: Ontological Engineering – Categories and Objects – Events – Reasoning Systems for Categories – Reasoning with Default Information – **Quantifying Uncertainty:** Acting under Uncertainty – Basic Probability Notation – Bayes' Rule – **Probabilistic Reasoning:** Representing Knowledge in an Uncertain Domain –The Semantics of Bayesian Networks – Exact Inference in Bayesian Networks – Approximate Inference in Bayesian Networks – First order Probability Models. **Probabilistic Reasoning over time:** Hidden Markov Models – Dynamic Bayesian Networks.

UNIT IV

Making Simple Decisions: The Basis of Utility Theory – Utility Functions – Decision Networks – Decision Theoretic Expert Systems – **Making Complex Decision**: Game theory –**Learning**

from Examples: Forms of Learning – Supervised Learning – Decision Trees – Regression and Classification with Linear Models – ANN – SVM – Ensemble Learning – Practical Machine Learning. – **Knowledge in Learning**: A Logical Formulation of Learning – Explanation based Learning. – **Learning Probabilistic Models**: Statistical Learning –Learning with Complete Data – Hidden Variables: EM Algorithm.

UNIT V

Natural Language Processing: Language Models – Text Classification – Information Retrieval – Information Extraction. – **Reinforcement Learning**: Passive Reinforcement Learning – Application of Reinforcement Learning. – **Natural Language for Communication:** Phrase Structure grammars – Syntactic Analysis – Machine Translation. – **Perception**: Image Formation – object Recognition –Reconstructing the 3D World. – **Robotics:**Robot Hardware – Robot Perception – Planning to Move and Uncertain Movements – Robotic Software architecture.

Reference Books:

1. Stuart Russel, Peter Norvig, "Artificial Intelligence: A Modern Approach – 3 /e", Pearson Education.2014.
2. Stuart Russel, Peter Norvig, "Artificial Intelligence: A Modern Approach – 2 /e", Pearson Education, 2003.
3. Elaine Rich, Kevin Knight, "Artificial Intelligence" 2/e, TMH, 1991.
4. Dan W. Patterson, "Introduction to Artificial Intelligence & Expert Systems", EEE, PHI, 1999.

Course Outcomes:

Upon successful completion of this course, the student shall be able to:

- Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.
- Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.
- Demonstrate a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models, Robotics.
- Demonstrate proficiency in applying scientific method to models of machine learning and Robotics.
- Demonstrate an ability to share in discussions of AI, its current scope and limitations, and societal implications.

19URCSC0E11 DEEP NEURAL NETWORKS

Course Objectives

This course will stimulate students to,

- Learn the concepts of Deep Networks
- Understand and implement algorithms of Deep Neural Network
- Get insights about Deep Learning with its Applications
- Develop Models using Deep Learning Techniques

UNIT-I

Deep Networks: Modern Practices - Deep Feedforward Networks: Gradient-Based Learning – Hidden Units – Architecture Design – Back-Propagation and other Differentiation Algorithms – Regularization for Deep Learning: Dataset Augmentation -Noise Robustness – Semi Supervised Learning – Multitask Learning – Sparse Representation – Bagging ad Other Ensemble Methods – Dropout.

UNIT-II

Optimization: Basic Algorithms – Algorithms with Adaptive Learning Rates – Approximate Second-Order Methods – Optimization Strategies and Meta Algorithms – Convolution Networks: Convolution Operation – Pooling – Variants – Structured Outputs – Efficient Convolution algorithms – Random or Unsupervised Features – Sequence Modelling: Recurrent Neural Networks – Bidirectional RNNs – Deep Recurrent Networks – Recursive Neural Networks – Echo State Networks.

Unit-III

Computer Vision – Speech Recognition – Natural Language Processing – Deep Learning Research: Linear Factor Models: Probabilistic PCA and Factor Analysis – ICA – Manifold Interpretation of PCA – Autoencoders: Regularized Autoencoders – Stochastic Encoders and Decoders – Contractive Autoencoders – Representation Learning: Greedy Layer-Wise Unsupervised Pretraining.

UNIT-IV

Monte Carlo Methods: Sampling and Monte Carlo Methods – Markov Chain Monte Carlo Methods – Gibbs Sampling – Comforting the Partition Function: The Log-Likelihood Gradient – Stochastic Maximum Likelihood and Contrastive Divergence – Score Matching and Ratio Matching.

UNIT-V

Approximate Inference: Inference as Optimization – Expectation Maximization – Learned Approximate Inference – Deep Generative Models – Boltzmann Machines – Deep Boltzmann Networks – Convolution Boltzmann Machines – Directed Generative Nets – Generative Stochastic Networks – Evaluating Generative Models.

Reference Books

1. Ian Goodfellow, YoshuaBengio and Aaron Courville, "Deep Learning", The MIT Press, Cambridge, 2016
2. Li Deng and Dong Yu, "Deep Learning: Methods and Applications", Vol. 7, Nos. 3-4, Foundations and Trends in Signal Processing, 2013.
3. Josh Patterson & Adam Gibson, "Deep Learning – A Practitioner's Approach", O'Reilly, 2017.
4. Simon Haykin, "Neural Networks and Learning Machines" 3e, Pearson Education, 2009.

Course Outcome:

At the end of the course the students will be able to,

- Understand algorithms including Back Propagation.
- Implement Optimization techniques
- Design and implement Deep Neural Networks
- Evaluate and interrupt the results of algorithms
- Build intelligent applications using Neural Network concepts.

19URCSC0E12 NATURAL LANGUAGE PROCESSING

Course objectives:

- To understand how key concepts from NLP and linguistics are used to describe and analyze language.
- To Learn about the data structures and algorithms used in NLP.
- To Analyze data is stored in standard formats
- To understand the methods and algorithms used to process different types of textual data

Unit I

Language Processing and Python: Computing with Language: Texts and Words - A Closer Look at Python - Computing with Language - Back to Python - Automatic Natural Language Understanding. **Accessing Text Corpora and Lexical Resources:** Accessing Text Corpora - Conditional Frequency Distributions - More Python: Reusing Code - Lexical Resources – WordNet.

Unit II

Processing Raw Text: Accessing Text from the Web and from Disk – Strings - Text Processing with Unicode - Regular Expressions for Detecting Word Patterns - Useful Applications of Regular Expressions - Normalizing Text - Regular Expressions for Tokenizing Text – Segmentation – Formatting. **Writing Structured Programs** – Sequences - Questions of Style – Functions - Doing More with Functions - Program Development - Algorithm Design - A Sample of Python Libraries.

Unit III

Categorizing and Tagging Words: Using a Tagger - Tagged Corpora - Mapping Words to Properties Using Python Dictionaries - Automatic Tagging - N-Gram Tagging - Transformation-Based Tagging - How to Determine the Category of a Word. **Learning to Classify Text:** Supervised Classification – Evaluation - Decision Trees - Naive Bayes Classifiers - Maximum Entropy Classifiers - Modeling Linguistic Patterns.

Unit IV

Extracting Information from Text: Information Extraction – Chunking - Developing and Evaluating Chunkers - Recursion in Linguistic Structure - Named Entity Recognition - Relation Extraction. **Analyzing Sentence Structure:** Some Grammatical Dilemmas - Context-Free Grammar - Parsing with Context-Free Grammar - Dependencies and Dependency Grammar - Grammar Development.

Unit V

Building Feature-Based Grammars: Grammatical Features - Processing Feature Structures - Extending a Feature-Based Grammar. **Analyzing the Meaning of Sentences:** Natural Language Understanding - Propositional Logic - First-Order Logic - The Semantics of English Sentences - Discourse Semantics.

Reference books:

1. Steven Bird, Ewan Klein, and Edward Loper, "Natural Language Processing with Python", O'Reilly, 2009.
2. NitinIndurkhya, Fred J. Damerau, "Handbook of Natural Language Processing", CRC Press, 2010.
3. Dwight Gunning, Sohom Ghosh, Natural Language Processing Fundamentals, Packt Publishers,2019.
4. Brian McMahan and Delip Rao, "Natural Language Processing with PyTorch: Build Intelligent Language Applications Using Deep Learning", O'Reilly, Firs edition, 2019.
5. Hobson Lane, Hannes Hapke, and Cole Howard, "Natural Language Processing in Action: Understanding, analyzing, and generating text with Python", Manning Publications, First edition, 2019.
6. Adarsha Shivananda and Akshay Kulkarni, "Natural Language Processing Recipes: Unlocking Text Data with Machine Learning and Deep Learning Using Python", APress, 2019.

Course outcomes:

On completion of this course, scholars should be able to

- Demonstrate the Extraction of information from text and classification of text
- Understand semantics and pragmatics of English language for processing.
- Write programs in Python to carry out natural language processing.

- Demonstrate knowledge of the fundamental principles of natural language processing.

19URCSC0E13 **QUANTUM COMPUTING**

Course objectives:

- To provide a deep knowledge on fundamental concepts of Quantum computing and its algorithm.
- To provides a better understanding to apply the various quantum computing algorithm.

Unit I

Quantum computer basics: Quantum information – Information processing – Quantum circuits – Quantum mechanics: General structure – Quantum states – Quantum bits and quantum gates: Single-qubit gates – Two qubit gates – Universal sets of gates – Quantum state transformations: Unitary transformation – Pauli transformation – Hadamard transformation – Multiple and single qubit transformation –Fourier transformation.

Unit II

Quantum measurement theory: Projective measurement – Composite systems – Generalized measurements – Positive operator-valued measures – Entanglement: Bells theorem – Bipartite systems – Entangles state – Pauli representation – Entangled fidelity – Density operator representation – Schmidt decomposition – Purification.

Unit III

Quantum algorithm: Quantum parallelism – Notions of complexity – Subroutine – Simple algorithms: Deutsch algorithm – Deutsch – Jozsa algorithm – Bernstein –Vazirani algorithm – Simon's algorithm – Machine models and complexity classes – Shor's algorithm – Grover's algorithm and Generalization

Unit IV

Quantum error correction: Framework for error correcting codes – CSS codes – Stabilizer codes – CSS codes as stabilizer codes – Fault tolerance and robust quantum computing: Setting the stage – Steane's code – Robust quantum computation

Unit V

Quantum cryptography: RSA encryption – Quantum cryptography – Controlled NOT attack – B92 Protocol – E 91 protocol – Cluster state quantum computing: Cluster states – Adjacency matrices – Stabilizer states – Entanglement witness – Cluster state processing.

Reference books

1. Eleanor Rieffel, Wolfgang H. Polak, "Quantum computing: A Gentle introduction", MIT Press, England, 2011

2. Mikio Nakahara, Tetsuo Ohmi, “Quantum computing from Linear algebra to Physical realization”, CRC Press – A Taylor and Francis book, 2008.
3. David Mc Mahon, “Quantum computing explained”, John wiley and Sons, 2007
4. Mika Hirvensalo, “Quantum computing”, Natural computing series, Springer-Verlag Berlin Heidelberg, 2001
5. Joachim Sotlze, Dieter suter, “Quantum computing – A short course from theory to experiment” Wiley-VCH, 2004.

Course Outcomes:

- Learners can able to explore the features of Quantum computing and importance of quantum computing.
- Researchers can easily solve the various research problem using quantum computing techniques.

19URCSC0E14 ADVANCED MACHINE LEARNING TECHNIQUES

Course Objectives:

- To introduce advanced concepts of machine learning techniques using tensorflow package.
- To introduce the concept of learning patterns from data and develop a strong theoretical foundation for understanding state of the art Machine Learning algorithms.
- To implement Hidden Markov model, Recurrent Neural Networks, Sequence to Sequence Model etc.. using machine learning techniques

Unit-I

TensorFlow Essentials: Ensuring TensorFlow Works- Representing Tensors-Creating Operators- Executing Operators with Sessions- Using Variables- Saving, Loading and Visualizing the data using TensorFlow – Linear Regression- Polynomial Model-Regularization-Applications of Linear Regression

Unit-II

Classification: Introduction- Formal Notation-Measuring Performance –Using Linear Regression for classification - Using Logistic Regression – Multiclass Classifier- Applications of classifications-**Automatically Clustering Data:** Traversing files in TensorFlow-Extracting Features-KMeans Clustering- Segmentation- Clustering using SOM- Applications

Unit-III

Hidden Markov Model: Markov Model – Hidden Markov Model – Forward Algorithm – Viterbi decode- Uses of Hidden Markov Model- Applications- **AutoEncoders:** Neural networks- Autoencoders- Batch Training –Working with Images- Applications of Autoencoders

Unit-IV

Reinforcement Learning: Formal Notation-Applying Reinforcement Learning-Implementations- Applications of Reinforcement Learning- **Convolution Neural Networks (CNNs):** Drawbacks of Neural Networks- CNN- Preparing the image-Implementing a CNN in TensorFlow-Tips and Tricks to improve performance- Applications of CNN

Unit-V

Recurrent Neural Networks(RNNs): Contextual Information – Introduction of RNN-Implementing RNN- Predictive Model for Time Series data- Applications of RNN- **Sequence to**

Sequence Model: Classifications- RNN- Classifications and RNN- Seq-to-Seq architecture – Vector Representations of Symbols- Putting it all altogether- Gathering Dialogue Data

Reference Books

1. NishantShukla, "Machine Learning with TensorFlow" ,MEAP Edition, Manning Publications, 2017.
2. Jason Brownlee, "Master Machine Learning Algorithms", 2016.
3. Abhishek Vijayvargia, "Machine Learning with Python Language", BPB, 2018 edition, 2018.
4. John Paul Mueller, Luca Massaron , "Machine Learning (in Python and R)" , For Dummies Publication, 2016.

Course Outcomes:

- Understand the concept of machine learning techniques for various algorithms
- Develop an appreciation for what is involved in learning models from data.
- To evaluate machine learning 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.

19URCSC0E15 HIGH PERFORMANCE COMPUTING

Course Objectives:

- To introduce the fundamentals of high performance computing with the graphics processing units and their architectures and corresponding programming environments.
- To introduce the learner to fundamental and advanced parallel algorithms through the GPU programming environments

Unit-I

Introduction to Novel Microprocessor Architectures : Introduction -Modern commercial multicore processors - Basic Components of a Computer - Characteristics of Modern Processors - Classification of Computer Architectures -Parallel Computer Memory Architectures - Measuring Performance -High-Performance Optimization Methods - Unconstrained Iterative Optimization Methods -Unconstrained Optimization Using Parallel Computing - Global Optimization Using Memetic Algorithms

Unit-II

Graphics Processing Unit Programming and Applications - CUDA: ComputeUnified Device Architecture- CUDA Programming: Fractal Generation anddisplay - GPU-based Conjugated Gradient Solution for Phase : Introduction –conjugate Gradient Method - Phase Field Model - Results

Unit-III

Parallel Computing Applied to a Diffusive Model : Introduction - Random Walk – Continuous Distributions -Solution via Finite Difference Approach - High Performance Computing Resources- A Parallel Implementation of the NSGA-II : Introduction – Basic Concepts - Genetic Algorithms - NSGA-II -Parallel Implementation of NSGA-II (PNSGA-II) - Results

Unit-IV

High-performance Navigation System for Mobile Robots -Introduction - Artificial Potential Field - Genetic Algorithms - High-performance Implementation - Phase 1: Simple navigation system with artificial potential field - Phase 2: Complete navigation system with artificial potential field and genetic algorithms -Phase 3: High-performance navigation system with artificial potential field and parallel genetic algorithms –Results -Quantum Computing- Introduction - Classic Computation – Basic Mathematics Used in Quantum Computing - Quantum Mechanic: Basic Principles - Elements of Quantum Computing

Unit-V

A Method Using a Combination of Ant Colony Optimization -Variants with Ant Set Partitioning-Introduction - Ant Colony Optimization (ACO) - Proposed Method – Methodology-Experiments - Simulation - **Variants of Ant Colony Optimization: A Metaheuristic for Solving the Traveling Salesman Problem** - Introduction - ACO Variants -Traveling Salesman Problem (TSP) -Elitist Ant System - Rank based ant system - Max-Min ant system - Ant Colony System (ACS) - Graphical Interface in Matlab - Sequential Processing - Parallel Processing - Simulation Results –Speedup

Reference Books

1. Oscar Montiel Ross and Roberto Sepúlveda Cruz, "High Performance Programming for Soft Computing", CRC Press, 2014
2. John Levesque,GeneWagenbreth , "High Performance Computing: Programming and Applications", First Edition, CRC Press, 2010
3. Charles Severance, Kevin Dowd, "High Performance Computing", OpenStaxCNX, 2010.
4. Roma A. Kudale and Snehal Kulkarni, "High Performance Computing", Vishwkarma Publications , 2016

Course Outcomes

The learner will be able

- To design, formulate, solve and implement high performance versions of standard single threaded algorithms
- To know and will be able to demonstrate the architectural features in the GPU hardware accelerators.
- To design and deploy large scale parallel programs on parallel Systems.

19URCSC0E16 **Digital Image Analysis**

Course Objectives:

- To provide complete knowledge on Computer Vision Techniques, such as Image transforms, Image enhancement in spatial domain, Image enhancement in Frequency domain, Image restoration, Denoising, Image Segmentation, Object Recognition, Image Compression and basic understanding of Computer Vision concepts.
- To understand these concepts and implement them empirically.

UNIT I

Introduction and Image Transforms: Introduction - Image Sampling - Quantisation - Resolution - Human Visual System - Classification of Digital Images - Image Types - Elements of an Image Processing System - Image File Formats - Applications of Digital Image Processing - Image Transforms: 2D Discrete Fourier Transform (DFT) - Properties of 2D-DFT - Types of Transform: Walsh – Hadamard - Haar - Slant – Discrete Cosine Transform (DCT) – Karhunen - Loeve Transform (KL Transform) - Singular Value Decomposition – Radon - Comparison of Different Image Transforms.

UNIT II

Image Enhancement and Restoration: Introduction - Spatial domain: Point Operation – Types of Point Operation - Histogram Manipulation - Linear and Non-Linear Gray-level Transformations - Local or Neighborhood Operation - Median Filter - High-pass Filtering or Image sharpening - Frequency Domain: Homomorphic Filter - Zooming Operation - Image Arithmetic - Image Restoration: Image Degradation - Classification of Image Restoration Techniques - Image Restoration Model - Linear and Non-Linear Image Restoration Techniques- Blind Deconvolution - Classification of Blind Deconvolution Techniques - Image Denoising: Classification of Noise in Image - Median Filtering - Trimmed Average Filter - Performance Metrics in Image Restoration.

UNIT III

Image Segmentation: Introduction – Classification of Image Segmentation Techniques – Region Approach to Image Segmentation – Clustering Techniques – Image Segmentation based on Thresholding – Edge-based Segmentation - Classification of Edges - Edge Detection - Edge Linking - Hough Transform - Active Contour - Watershed Transformation - Shape Representation - Classification of Shape-representation Techniques.

UNIT IV

Object Recognition: Introduction – Need for an Object Recognition System – Automated Object Recognition Systems - Patterns and Pattern Class – Selection of Measurement Parameters - Relationship between Image Processing and Object Recognition – Approaches to Object Recognition – Baye's Parametric Classification – Template-Matching-based Object Recognition - Non-Parametric Density Estimation - Applications of Object Recognition.

UNIT V

Image Compression: Introduction - Need for Image Compression – Redundancy in Images – Classification of Redundancy in Images – Image-Compression Scheme - Classification of Image-Compression Schemes - Fundamentals of Information Theory - Run-length Coding - Shannon-Fano Coding - Huffman Coding - Arithmetic Coding - Dictionary-based Compression - Predictive Coding - Transform-based Compression - Image-Compression Standard - Scalar Quantisation - Vector Quantisation -Types of Vector Quantisation - Wavelet-based Image Compression - Fractal Image Compression - Block Truncation Coding.

Reference Books:

1. S. Jayaraman, S. Esakkirajan, T.Veerakumar, Digital Image Processing, Tata McGraw Hill, Fourth Edition, 2011.
2. R. C. Gonzalez, R. E. Woods. Digital Image Processing. Addison Wesley Longman, Inc., 2008.
3. A.K. Jain, Fundamentals of Image processing, Prentice Hall of India Publication, 1995.
4. Richard Szeliski, Computer Vision: Algorithms and Applications (CVAA). Springer, 2010.

Course Outcomes:

After learning the course the students should be able to:

1. To implement fundamental digital image processing techniques required for computer vision.
2. Understand an image noise removal, enhancement, compression for efficient storage and transmission, object extraction, representation and description for recognition or building computer vision.
3. Image segmentation from images and do analysis of images.
4. To develop applications using computer vision techniques.