POSTGRADUATE DEGREECOURSES
IN

COMPUTER SCIENCE
&
ENGINEERING

(Artificial Intelligence and Machine Learning)

(Engineering&Technology)

[Proposed Syllabus – 2023 onwards]

Department of Computer Science & EngineeringDibrugarh University Institute of Engineering andTechnology,DibrugarhUniversity Dibrugarh, Assam-786004India

Semester-wisestructureofcurriculum

[L=Lecture,T=Tutorials, P=Practical's&C=Credits]

Semester I (First year]
CurriculumBranch/Course:ComputerScienceE ngineering

Sl. No.	Course Code	CourseTitle	Hoursperweek			Credits
			Lecture	Tutorial	Practical	
1	M. Tech-CSE-101	Mathematics for Machine Learning	3	0	0	3
2	M. Tech-CSE-111	Mathematics for Machine Learning Laboratory	0	0	2	1
3	M. Tech-CSE-102	Advanced-Data Structures	3	0	0	3
4	M. Tech-CSE-112	Advanced-Data Structures Laboratory	0	0	2	1
5	M. Tech-CSE-103	Data Warehousing & Pattern Mining	0	0	2	3
6	M. Tech-CSE-113	Data Warehousing & Pattern Mining Laboratory	0	0	2	1
7	M. Tech-CSE-104	Data Visualization & Machine Learning	3	0	0	3
8	M. Tech-CSE-114	Data Visualization & Machine Learning	0	0	2	1
9	M. Tech-CSE-105	Research Methodology and IPR	3	0	0	3
Total Credits						**19**

Semester II (First year)
CurriculumBranch/Course:ComputerScienceE ngineering

Sl. No.	Code	CourseTitle	Hoursperweek			Credits
			Lecture	Tutorial	Practical	
1	M. Tech-CSE-201	Optimization Technique	3	0	0	3
2	M. Tech-CSE-202	Deep Neural Network	3	0	0	3
3	M. Tech-CSE-212	Deep Neural Network Laboratory	0	0	2	1
4	M. Tech-CSE-203	Artificial Intelligence & Knowledge Representation	3	0	0	3
5	M. Tech-CSE-213	Artificial Intelligence & Knowledge Representation Laboratory	0	0	2	1
6	M. Tech-CSE-204	Natural Language Processing	3	0	0	3
7	M. Tech-CSE-214	Natural Language Processing Laboratory	0	0	2	1
8	M. Tech-CSE-205	Elective-I	3	0	0	3
Total Credits						**18**

Elective-I Subjects:

(i) Reinforcement Learning
(ii) Graph Representation Learning
(iii) Information Retrieval
(iv) Knowledge Engineering and Expert Systems
(v) Number Theory & Cryptography

Semester III (Second year]
CurriculumBranch/Course:ComputerScienceEngineering

Sl. No.	Code	CourseTitle	Hoursperweek			Credits
			Lecture	Tutorial	Practical	
1	M. Tech-CSE-301	Technical Writing	0	0	2	0
2	M. Tech-CSE-312	Project-I	0	0	30	15
Total Credits						**15**

Semester IV (Second year]
CurriculumBranch/Course:ComputerScienceEngineering

Sl. No.	Code	CourseTitle	Hoursperweek			Credits
			Lecture	Tutorial	Practical	
1	M. Tech-CSE-411	Project-II	0	0	32	16
Total Credits						**16**

SEMESTER-I

CourseCode	CourseName	Credits			
		L	T	P	C
M. Tech-CSE-101	MathematicsforMachineLearning	3	0	0	3

UNITI:PROBABILITY

Classical, relative frequency and axiomatic definitions of probability, addition rule and conditionalprobability,multiplicationrule, totalprobability, Bayes'Theoremand independence.

UNITII:RANDOM VARIABLES

Discrete, continuous and mixed random variables, probability mass, probability density andcumulative distribution functions, mathematical expectation, moments, moment generating function,Chebyshev'sinequality

UNITIII:STOCHASTICPROCESSES

Introduction to Stochastic Processes (SPs), Stationary Processes, Discrete-time Markov Chains(DTMCs),Continuous-time MarkovChains (CTMCs)

UNITIV:LINEAR ALGEBRA

Finite dimensional vector spaces over a field; linear combination, linear dependence andindependence; basis and dimension; inner-product spaces, linear transformations; matrixrepresentationof linear transformations

UNITV:LINEAR ALGEBRA

Eigen values and eigenvectors, rank and nullity, inverse and linear transformation, Cayley-HamiltonTheorem

REFERENCES:

1. SheldonRoss,A FirstCourseinProbability, 7thEdition,Pearson,2006
2. J.Medhi,StochasticProcesses,3rdEdition,NewAgeInternational,2009.
3. S.M.Ross,StochasticProcesses,2ndEdition,Wiley,1996.
4. Stephen H Friedberg, Arnold J Insel, Lawrence E. Spence, Linear Algebra. 4th Edition,Pearson,2006.
5. KennethMHoffman,RayKunz,LinearAlgebra,2ndEdition,Pearson.

CourseCode	CourseName	Credits			
		L	T	P	C
M. Tech-CSE-102	Advanced Data Structures	3	0	0	3

UNITI:
Dictionaries: Definition,DictionaryAbstractDataType,ImplementationofDictionaries.
Hashing: ReviewofHashing,HashFunction,CollisionResolutionTechniquesinHashing,SeparateChaining,OpenAddressing,LinearProbing,QuadraticProbing,DoubleHashing,Rehashing,ExtendibleHashing.

UNIT II:
SkipLists: Need forRandomizingDataStructuresand Algorithms,SearchandUpdateOperationsonSkipLists,ProbabilisticAnalysisofSkipLists,DeterministicSkip Lists

UNIT III:
SkipLists: Trees: Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees, Splay Trees

UNIT IV:
Text Processing: Sting Operations, Brute-Force Pattern Matching, The Boyer- Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem.

UNIT V:
Computational Geometry: One-Dimensional Range Searching, Two-Dimensional Range Searching, Constructing a Priority Search Tree, Searching a Priority Search Tree, Priority Range Trees, Quadtrees, k-D Trees.

UNIT VI:
Recent Trends in Hashing, Trees, and various computational geometry methods for efficiently solving the new evolving problem

REFERENCES:

1. MarkAllenWeiss,DataStructuresand AlgorithmAnalysisinC++,2ndEdition,Pearson,2004.
2. M TGoodrich,RobertoTamassia,AlgorithmDesign,John Wiley,2002.

CourseCode	CourseName	Credits			
		L	T	P	C
M.Tech-CSE-103	DataWarehousingandPatternMining	3	0	0	3

UNIT I:
Datawarehouseconcepts,Datawarehousemodeling,DataCubeandOLAP,schemasformultidimensionaldatamodels,concepthierarchy,measures,andindexingtechniques.Datawarehouse designandusage,implementation,architecturalcomponents,RoleofMetadata,DimensionalModeling,Data Extraction, Transformation andLoading,Data Quality.

UNITII:
Classification and prediction; Cluster Analysis – Types of Data in Cluster Analysis, Partitioningmethods,HierarchicalMethods;TransactionalPatternsandothertemporalbasedfrequentpatterns. Mining Time series Data, Periodicity Analysis for time related sequence data, Trend analysis, andSimilaritysearch in Time-series analysis.

UNITIII:
Mining Data Streams, Methodologies for stream data processing and stream data systems, Frequentpattern mining in stream data, Sequential Pattern Mining in Data Streams, Classification of dynamicdatastreams.

UNITIV:
Web Mining, Mining the web page layout structure, mining web link structure, mining multimediadata on the web, Automatic classification of web documents and web usage mining; Distributed DataMining.

UNITV:
Recent trends in Distributed Warehousing and Pattern Mining, Class Imbalance Problem; GraphMining;Social NetworkAnalysis.

REFERENCES:
1. JiaweiHanandMKamber,DataMiningConceptsandTechniques,SecondEdition,ElsevierPublication,2011.
2. VipinKumar,IntroductiontoDataMining-Pang-NingTan,MichaelSteinbach,AddisonWesley,2006.
3. GDongand JPei,SequenceDataMining, Springer,2007.
   RalphKimball,MargyRoss,TheDataWarehouseToolkit,3rdedition,Publisher:Wiley,2013

CourseCode	CourseName	Credits			
		L	T	P	C
M. Tech-CSE-113	DataWarehousingandPatternMiningLab	0	0	2	1

LISTOFPRACTICALEXPERIMENTS

1. BasicexercisesonPython Packagessuch asNumpy, Pandasandmatplotlib.
2. Givenadataset.WriteaprogramtocomputetheMean,Median,Mode,Standarddeviation,Covariance,Correlationbetweenapair ofattributes.
3. Writeaquery toimplementation OLAPoperations ina datacube.
4. Writeaprogram toimplementdatapre-processingtechniques.
5. Writeaprogramtoimplementdatatransformationusingdifferentnormalizationtechniques.
6. Write a program that provides option to compute different distance measures between twopoints in the N dimensional feature space. Consider some sample datasets for computingdistancesamong samplepoints.
7. Write a program to demonstrate the working of APRIORI algorithm. Use an appropriate datasetto generatefrequent patterns.
8. Write a program to demonstrate the working of stream mining algorithm. Use an appropriatedataset to generate frequent patterns.
9. Write a program to implement K means clustering algorithm. Select your own dataset to testtheprogram. Demonstratethe natureof output with varying valueof K.
10. Writeaprogramto demonstratewebpagelayout structure,weblinkstructure.
11. Writeaprogramto demonstrate graphmining considering asuitabledataset.

CourseCode	CourseName	Credits			
		L	T	P	C
M. Tech-CSE-104	Data Visualization and Machine Learning	3	0	0	3

UNIT I: DATA VISUALIZATION
Consideration While Loading CSV data, Methods to Load CSV Data File, Load CSV with NumPy, Load CSV with Pandas, Looking at Raw Data, Checking Dimensions of Data, Getting Each Attribute's Data Type, Statistical Summary of Data, Reviewing Class Distribution, Reviewing Correlation between Attributes, Reviewing Skew of Attribute Distribution, Univariate Plots: Understanding Attributes Independently, Density Plots, Box and Whisker Plots, Multivariate Plots: Interaction Among Multiple Variables, Correlation Matrix Plot, Scatter Matrix Plot.

UNIT II: PREPARING DATA AND FEATURE SELECTION
Introduction, Why Data Pre-processing? Data Pre-processing Techniques, Normalization, Types of Normalization, Binarization, Standardization, Data Labeling, what is Label Encoding? Importance of Data Feature Selection, Feature Selection Techniques, Recursive Feature Elimination, Principal Component Analysis (PCA), Feature Importance.

UNIT III: CLASSIFICATION ALGORITHMS
Introduction to Classification, Types of Learners in Classification, Building a Classifier in Python, Classification Evaluation Metrics, Confusion Matrix, Various ML Classification Algorithms, Applications,
Logistic Regression: Introduction to Logistic Regression, Types of Logistic Regression, Logistic Regression Assumptions, Binary Logistic Regression model, Implementation in Python, Multinomial Logistic Regression Model, Implementation in Python
Support Vector Machine (SVM): Introduction to SVM, Working of SVM, Implementing SVM in Python, SVM Kernels Pros and Cons of SVM Classifiers
Decision Tree: Introduction to Decision Tree, Implementing Decision Tree Algorithm, Building a Tree, Implementation in Python
Naïve Bayes: Introduction to Naïve Bayes Algorithm, building model using Naïve Bayes in Python, Pros & Cons, Applications of Naïve Bayes classification
Random Forest: Introduction, Working of Random Forest Algorithm, Implementation in Python, Pros and Cons of Random Forest

UNIT IV: CLUSTERING ALGORITHMS
Overview, Introduction to Clustering, Cluster Formation Methods, Measuring Clustering Performance, Silhouette Analysis, Analysis of Silhouette Score, Types of ML Clustering Algorithms Applications of Clustering.
K-means Algorithm: Introduction to K-Means Algorithm, Working of K-Means Algorithm, Implementation in Python, Advantages and Disadvantages, Applications of K-Means Clustering Algorithm
Mean Shift Algorithm: Introduction to Mean-Shift Algorithm, Working of Mean-Shift Algorithm, Implementation in Python, Advantages and Disadvantages
Hierarchical Clustering: Introduction to Hierarchical Clustering, Steps to Perform Agglomerative Hierarchical Clustering, Role of Dendrograms in Agglomerative Hierarchical Clustering

REFERENCES:
1. Data Mining – Concepts and Techniques – Jiawei Han & Micheline Kamber, 3rd Edition Elsevier.
2. Data Mining Introductory and Advanced topics – Margaret H Dunham, PEA.

ResearchMethodologyandIPR

TeachingScheme

Lectures:1hrs/week

Course Outcomes:

Attheend of thiscourse,studentswill beableto

- Understandresearchproblemformulation.
- Analyzeresearchrelatedinformation
- Followresearch ethics
- Understandthattoday'sworldiscontrolledbyComputer,InformationTechnology,buttomorrow worldwill beruled by ideas,concept, and creativity.
- UnderstandingthatwhenIPRwouldtakesuchimportantplaceingrowthofindividuals&nation,iti sneedlesstoemphasistheneedofinformationabout Intellectual Property Right to be promoted among students in general & engineeringinparticular.
- UnderstandthatIPRprotectionprovidesanincentivetoinventorsforfurtherresearch work and investment in R & D, which leads to creation of new and betterproducts,and inturnbringsabout,economicgrowth andsocialbenefits.

SyllabusContents:

Unit1: Meaningofresearchproblem,Sourcesofresearchproblem,CriteriaCharacteristics of a good research problem, Errors in selecting a research problem, Scopeand objectivesofresearchproblem.
Approachesofinvestigationofsolutionsforresearchproblem,datacollection,analysis,interpretation, Necessaryinstrumentations

Unit 2: Effective literature studies approaches,

analysisPlagiarism,Researchethics,

Unit3: Effectivetechnicalwriting,how to writereport,Paper DevelopingaResearchProposal,Formatofresearchproposal,apresentationandassessmentbyarevie wcommittee

Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process ofPatenting and Development: technological research, innovation, patenting, development.International Scenario: International cooperation on Intellectual Property. Procedure forgrantsof patents,PatentingunderPCT.

Unit 5: PatentRights:ScopeofPatentRights.Licensingandtransferoftechnology.Patentinformation anddatabases.GeographicalIndications.

Unit 6: New Developments in IPR: Administration of Patent System. New developmentsin IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge CaseStudies,IPRandIITs.

References:

- StuartMelvilleandWayneGoddard,“Researchmethodology:anintroductionforscience&engineeringstudents’”
- WayneGoddardandStuartMelville,“ResearchMethodology:AnIntroduction”
- RanjitKumar,2ndEdition,“ResearchMethodology:AStepbyStepGuideforbeginners”
- Halbert,“ResistingIntellectualProperty”,Taylor&FrancisLtd,2007.
- Mayall,“IndustrialDesign”,McGrawHill,1992.
- Niebel,“Product Design”,McGrawHill,1974.
- Asimov,“Introduction toDesign”,PrenticeHall,1962.
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New Technological Age”, 2016.
- T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

SEMESTER-II

CourseCode	CourseName	Credits			
		L	T	P	C
M.Tech-CSE-201	OptimizationTechniques	3	0	0	3

UNITI:
HistoricalDevelopment;EngineeringapplicationsofOptimization;ArtofModeling,Objectivefunction;ConstraintsandConstraintsurface;Formulationofdesignproblemsasmathematicalprogramming problems. Classification of optimization problems, Optimization techniques –classicaland advanced techniques**,**IntroductiontoOperationResearch:OperationResearchapproach,scientificmethods,introductionto models and modeling techniques, general methods for Operation Research models, methodology andadvantagesof Operation Research, historyofOperation Research.

UNITII:
Linear Programming (LP): Introduction to LPand formulation of Linear Programming problems,Graphicalsolutionmethod,alternativeormultipleoptimalsolutions,Unboundedsolutions,Infeasiblesolutions, Maximization – Simplex Algorithm, Minimization – Simplex Algorithm using Big-Mmethod,Two phasemethod,Duality in linearprogramming, Integer linearprogramming.

UNITIII:
AllocationproblemsandGameTheory:IntroductiontoTransportationproblems,Transportationproblem – Methods of basic feasiblesolution-Optimalsolution–MODIMethod, Assignmentproblem-Hungarianmethod Gametheory:Twopeople-zerosumgame-mixedstages -Dominanceproperties

UNITIV:
Sequentialoptimization;RepresentationofmultistagedecisionprocessTypesofmultistagedecisionproblems;Conceptofsuboptimizationandtheprincipleofoptimality.Recursiveequations–Forwardand backward recursions; Computational procedure in dynamic programming (DP), Discrete versuscontinuous dynamic programming; Multiple state variables; curse of dimensionality in DP; Problemformulationandapplication inDesignof continuousbeamand optimalgeometriclayoutof atruss

UNITV:
NetworkAnalysis:NetworkdefinitionandNetworkdiagram,probabilityinPERTanalysis,projecttimecost tradeoff, introduction toresourcesmoothing and allocation
Sequencing:Introduction,processingNjobsthroughtwomachines,processingNjobsthroughthreemachines,processing N jobs through m machines.
InventoryModel:Introductiontoinventorycontrol,deterministicinventorymodel,EOQmodelwithquantitydiscount

REFERENCES

1. HamdyA.Taha,OperationsResearch,PrenticeHall,Pearso.
2. J.SArora,Introductiontooptimumdesign, IIndedition,ElsevierIndiaPvt.Ltd.,
3. S.S Rao,Optimization:theory andapplication, WileyEastern Ltd.,New Delhi.
4. WayneL.Winston-OperationsResearch_ApplicationsandAlgorithms-DuxburyPress(2003).
5. RavindraK.Ahuja,ThomasL.Magnanti,andJamesB.Orlin,NetworkFlows:Theory,Algorithms,and Applications, Pearson.
6. JKSharma,OperationsResearchTheoryandApplications,MacMillan IndiaLtd.
7. NDVohra,QuantitativeTechniquesinmanagement,TataMcGrawHill.
8. PayneTA,QuantitativeTechniquesforManagement:APracticalApproach,RestonPublishingCo. Inc., Virginia.
9. AchilleMessac, OptimizationinpracticewithMATLAB,CambridgeUniversityPress,2015.

		Credits

CourseCode	CourseName	L	T	P	C
M.Tech-CSE-202	Deep Neural Network	3	0	0	3

UNIT I:
Artificial Neural Networks Introduction, Basic models of ANN, important terminologies, Supervised Learning Networks, Perceptron Networks, Adaptive Linear Neuron, Back-propagation Network. Associative Memory Networks. Training Algorithms for pattern association, BAM and Hopfield Networks.

UNIT II:
Unsupervised Learning Network- Introduction, Fixed Weight Competitive Nets, Maxnet, Hamming Network, Kohonen Self-Organizing Feature Maps, Learning Vector Quantization, Counter Propagation Networks, Adaptive Resonance Theory Networks. Special Networks-Introduction to various networks.

UNIT III:
Introduction to Deep Learning, Historical Trends in Deep learning, Deep Feed - forward networks, Gradient-Based learning, Hidden Units, Architecture Design, Back-Propagation and Other Differentiation Algorithms

UNIT IV:
Regularization for Deep Learning: Parameter norm Penalties, Norm Penalties as Constrained Optimization, Regularization and Under-Constrained Problems, Dataset Augmentation, Noise Robustness, Semi-Supervised learning, Multi-task learning, Early Stopping, Parameter Typing and Parameter Sharing, Sparse Representations, Bagging and other Ensemble Methods, Dropout, Adversarial Training, Tangent Distance, tangent Prop and Manifold, Tangent Classifier

UNIT V:
Optimization for Train Deep Models: Challenges in Neural Network Optimization, Basic Algorithms, Parameter Initialization Strategies, Algorithms with Adaptive Learning Rates, Approximate Second Order methods, Optimization Strategies and Meta-Algorithms Applications: Large-Scale Deep Learning, Computer Vision, Speech Recognition, generative networks

REFERENCES:

1. Deep Learning: An MIT Press Book By Ian Goodfellow and Yoshua Bengio and Aaron Courville
2. Neural Networks and Learning Machines, Simon Haykin, 3rd Edition, Pearson Prentice Hall.

CourseCode	CourseName	Credits

		L	T	P	C
M.Tech-CSE-203	Artificial IntelligenceandKnowledgeRepresentation	3	0	0	3

UNIT I:
Introduction:AIproblems,foundationofAIandhistoryofAIintelligentagents:AgentsandEnvironments, the concept of rationality, the nature of environments, structure of agents, problemsolvingagents, problem formulation.

UNITII:
Searching: Searching for solutions, uniformed search strategies – Breadth first search, depth firstSearch. Search with partial information (Heuristic search) Greedy best first search, A* search GamePlaying: Adversial search, Games, minimax, algorithm, optimal decisions in multiplayer games,Alpha-Betapruning, Evaluation functions, cutting of search.

UNITIII:
KnowledgeRepresentation**:**UsingPredicatelogic,representingfactsinlogic,functionsandpredicates,Conversiontoclauseform,Resolutioninpropositionallogic,Resolutioninpredicatelogic,Unification.
RepresentingKnowledgeUsingRules**:**ProceduralVersusDeclarativeknowledge,LogicProgramming,Forward versus Backward Reasoning

UNITIV:
Learning: What is learning, Rote learning, Learning by Taking Advice, Learning in Problem-solving,Learningfrom example:induction, Explanation-based learning.
Connectionist Models: Hopfield Networks, Learning in Neural Networks, Applications of NeuralNetworks,RecurrentNetworks. Connectionist AIand SymbolicAI.

UNITV:
Expert System: Representing and using Domain Knowledge, Reasoning with knowledge, ExpertSystemShells, Support forexplanation examples,Knowledgeacquisition-examples.

REFERENCES:

1. ArtificialIntelligence–A Modern Approach. Second Edition, StuartRussel,Peter Norvig,PHI/Pearson Education.
2. ArtificialIntelligence,KevinKnight,ElaineRich,B.ShivashankarNair,3rd Edition,2008
3. ArtificialNeuralNetworksB.YagnaNarayana,PHI.
4. Artificial Intelligence,2ndEdition,E.RichandK.Knight(TMH).
5. Artificial IntelligenceandExpertSystems–PattersonPHI.
6. ExpertSystems:PrinciplesandProgramming-FourthEdn,Giarrantana/Riley,Thomson.
7. PROLOGProgrammingforArtificialIntelligence.IvanBratka-ThirdEdition–PearsonEducation.
8. NeuralNetworksSimonHaykinPHI.
9. Artificial Intelligence,3rdEdition,PatrickHenry Winston.,PearsonEdition.

CourseCode	CourseName	Credits			
		L	T	P	C

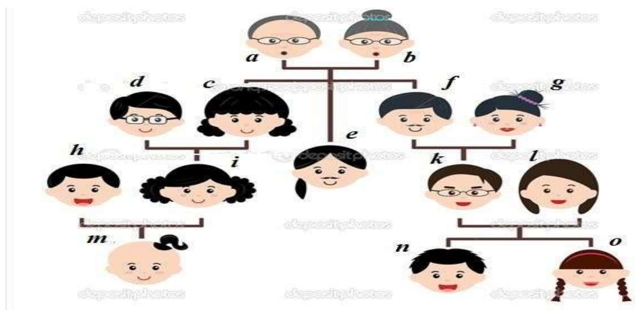
M.Tech-CSE-213	Artificial IntelligenceandKnowledgeRepresentationLab	0	0	2	1

LISTOFPRACTICALEXPERIMENTS

1. FamilyTree
2. Factorial,FibonacciSeries,andPrimeNumberChecking
3. Lists
4. EightQueensProblem
5. TowersofHanoiProblem
6. MedicalDiagnosisExpertSystem

LABEXERCISE1-FAMILYTREE

CreateaSWIProlog programtorepresent thefamilytreeshowninbelowdiagram.



The topmost, nodes are parents and bottom most nodes are children nodes. Nodes in the middleareparentor childorboth. All children havetwoarrowsgoingto itsparents.
Create the least number of relations that enables to answer the following questions related to thefollowing relations viz. Grandfather, Grandmother, Father, Mother, Son, Daughter, Uncle (FatherorMother's brother), Aunt (Father or Mother's sister), Husband, Wife, Brother, Sister, nephew (brotherorsister'sson),niece(brotherandsister'sdaughter),cousin(maleorfemale),grandson,granddaughteretc. Questions can be like 1) who is ***n's*** grandmother or what is the relation between ***a*** and ***b***? Show yourprogramworksbyansweringatleast 20relationqueriesthatcoverall therelationsmentionedabove.

LAB EXERCISE2-FACTORIAL,FIBONACCISERIESANDPRIMENUMBERCHECKING

Q1.FindwhetheranumberN is primeor not

Q2.FindfactorialofanumberN.
Q3.Find N^{th}termofFibonacciseries.
Q4.TranslatethefollowingtextintoPrologLogictoanswerthequeries:
Problem:A,BandCbelongtotheHimalayanclub.Everymemberintheclubiseitheramountainclimberoraskierorboth.Alikes whateverBdislikesanddislikes whateverBlikes.A likes rain and snow. No mountain climber likes rain. Every skier likes snow.Query1: Isthereamemberwho is amountainclimberandnotaskier? Query2:Isthereamemberwhoisbothamountain climberandaskier?Query3:Is thereamemberwho likes bothrainandsnow?

LABEXERCISE3-LISTS

ListsareimportantinProlog.Youwilloftenneedtopatternmatchagainstlists.CreateaprologfilenamedLab3_List_exercise.pl and create the following knowledgebase.

Writerulesfor:
isa_list/1 %argument isalist
memberof/2 %an element is a member of a listnonmember_of/2 %anelementisnot amemberofalistlength_of_list/2 %lengthoflist
bigger_than_one/1%thelisthasmorethanoneelement
same_head/2 %twolistshavethesameheadregardlessoftheir lengthprefix/2 %firstlististheprefix ofthesecond list
allfifferent/1 %usingnonmember_of/2 checkwhetherthe elementsofa list areall differentappend_list/3%append an elementto alisttomakeanew list
insert_at/4 %insertanelement toaspecifiedpositionofalist tomakeanewlistmerge_lists/3%mergetwolists tomakeanewlist

LABASSIGNMENT4-EIGHT QUEENSPROBLEM

Eight queens problem is a constraint satisfaction problem (CSP). The task is to place eight queensinthe 64 available squares in such a way that no queen attacks each other. So the problem can beformulated with variables x1, x2, x3, x4, x5, x6, x7, x8 and y1, y2, y3, y4, y5, y6, y7, y8; where thexsrepresenttherowsandysthecolumns.Nowasolutionforthisproblemistoassignvaluesforxandforysuchthattheconstraintissatisfied.Theproblemcanbeformulatedas:P={(x1,y1),(x2,y2),… .... (x8,y8)}where(x1,y1)givesthepositionofthefirstqueen and(x2,y2)ofthesecondqueenandsoon.So,itcanbeclearlyseenthatthedomainsforxiandyiareDx = {1,2,3,4,5,6,7,8} and Dy = {1,2,3,4,5,6,7,8} respectively. And the constraints are: i. No twoqueensshouldbeinthesamerow,i.eyi≠yjfori=1to8;j=1to8;ori≠jii.Notwoqueensshouldbeinthesamecolumn,i.exi≠xjfori=1to8;j=1to8;ori≠jiii.Thereshouldnotbetwoqueensplacedonthesame diagonal line i.e (yi-yj) ≠ ±(xi-xj). Write the required predicates tosolve the Eight Queensplacementproblem.

LABEXERCISE 5-TOWEROFHANOI

TheTowerofHanoipuzzlewas inventedbytheFrenchmathematicianEdouard Lucasin1883.
He was inspired by a legend that tells of a Hindu temple where the puzzle was presented to youngpriests. At the beginning of time, the priests were given three poles and a stack of 64 golddisks, eachdisk a little smaller than the one beneath it. Their assignment was to transfer all 64 disks from one ofthe three poles to another, with two important constraints. They could only move one disk at a time,and they could never place a larger disk on top of a smaller one. The priests worked very efficiently,day and night, moving one disk every second. When they finished their work, the legend said, thetemplewouldcrumbleintodustandtheworldwouldvanish.Althoughthelegendisinteresting,you

neednotworryabouttheworldendinganytimesoon.Thenumberofmovesrequiredtocorrectlyoveatower of64 disks is 264−1=18,446,744,073,709,551,615264−1=18,446,744,073,709,551,615,263.
At a rate of one move per second, that is 584,942,417,355 years! Clearly there is more to this puzzlethan meets the eye. Figure 1 shows an example of a configuration of disks in the middle of a movefrom the first peg to the third. Notice that, as the rules specify, the disks on each peg are stacked sothatsmallerdisksarealwaysontopofthelargerdisks.Ifyouhavenottriedtosolvethispuzzlebefore,you should try it now. You do not need fancy disks and poles–a pile of books or pieces ofpaper willwork. Write a Prolog program that efficiently keep track of the disk movements and that helps inrecursivelysolving theproblem of Towerof Hanoi.

LAB6-MEDICAL DIAGNOSISEXPERTSYSTEMDESIGN

Expert systems are computer applications which embody some non-algorithmic expertise forsolvingcertain types of problems. For example, expert systems are used in diagnostic applications servicingboth people and machinery. They also play chess, make financial planning decisions, configurecomputers,monitorrealtimesystems,underwriteinsurancepolicies,andperformmanyotherserviceswhichpreviously requiredhumanexpertise.
This Lab exercise is for Medical Diagnostic Expert system design which will hypothesis the name ofthe

disease by learning the symptoms the patient have. The table below shows the expert knowledgeabout symptoms and name of the disease. A prolog program will representthis expert knowledge intermsof rules in its knowledgebase.

Disease	**Symptoms**
Measles	Cough,sneezing,runny_nose
German measles	Fever,headache,runny_nose,rash
Common cold	Headache,sneezing,sore_throat,runnynose,chills
Flu	Fever,headache,body_ache,conjunctivitis,chills,sorethroat.Runnynose,cough
Mumps	Fever,swollenglands
Chickenpox	Fever,chills,body acherash

An expert system has several components as shown in the below figure. Other than the knowledgebaseothermaincomponents areuser interface, working storageand theinferenceengine.

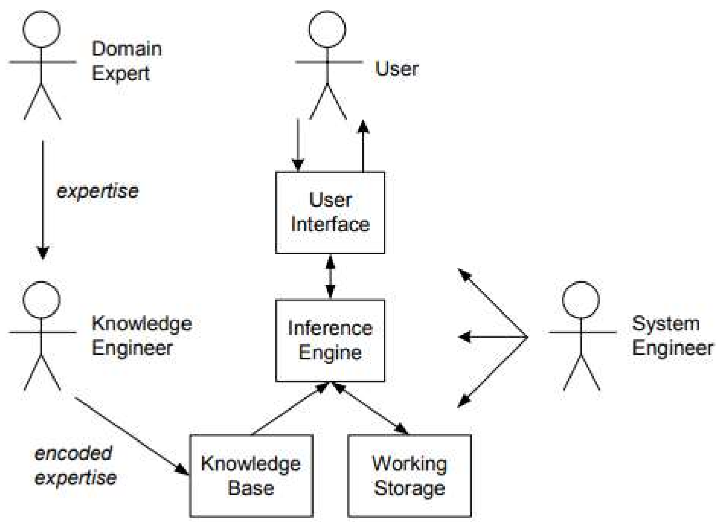


Figure 1.1 Expert system components and human interfaces

Prolog's inference engine is goal driven reasoning or backward chaining – an inference techniquewhichusesIFTHENrulestorepetitivelybreakagoalintosmallersub-goals,whichareeasiertoprove.For example, to hypothesis that a patient has a particular disease the patient should have all thesymptoms ofthatdiseaseas mentionedin thetable.

The expert system can be dramatically improved by providing a user interface which prompts forsymptom information from the patient when needed. Write a ask/2 predicate which ask the patientaboutthesymptomshehastodiagnoseadisease.Storeallthesesinformationgatheredfromthepatientin the working storage one by one. Choose an appropriate data representation asattribute-value pairlikesymptom(Patient,german_measles)etc.Assomesymptomsarecommoninmorethanonediseasethe same question should not the asked twice to the patient to dignose a second disease. Use Prolog'sin-builtpredicateassert/1toputinformationintheworkingstorage.Also,asyourprogramwillberunseveral times in the same session make sure to flush working storage before the next query. You canuseprolog'sin-built predicate retract/2inthebeginningof each query.

Attach a screen shot about how the program runs with various patient input and predicted diseaseoutput.

CourseCode	CourseName	Credits			
		L	T	P	C
M.Tech-CSE-204	NaturalLanguageProcessing	3	0	0	3

UNITI:
Introduction and Overview: Welcome, motivations, what is Natural Language Processing, hands-ondemonstrations. Ambiguity and uncertainty in language; The Turing test,NLPtasks in syntax;semantics,andpragmatics;Applicationssuchasinformationextraction;andmachinetranslation;Theproblemof ambiguity; Theroleof machine learning.

UNITII:
N-gramLanguageModels:Theroleoflanguagemodels;SimpleN-grammodels.Estimatingparametersand smoothing; evaluating languagemodels.
PartofSpeechTaggingandSequenceLabeling:Lexicalsyntax.HiddenMarkovModels(ForwardandViterbialgorithms and EM training).

UNITIII:
Syntactic parsing: Grammar formalisms and tree banks. Efficient parsing for context-free grammars(CFGs); Statistical parsing and probabilistic CFGs (PCFGs); Lexicalized PCFGs; Neural shift-reducedependencyparsing.
Semantic Analysis: Lexical semantics and word-sense disambiguation. Compositional semantics;SemanticRoleLabeling and Semantic Parsing.

UNITIV:
Maximum Entropy Classifiers, Maximum Entropy Markov Models & Conditional Random Fields,Dirichlet Multinomial Distributions, Unsupervised Language Discovery, Information Extraction &ReferenceResolution.

UNIT V:
InformationExtraction:Namedentityrecognitionandrelationextraction.IEusingsequencelabeling
MachineTranslation:BasicissuesinMT.Statisticaltranslation,wordalignment,phrase-basedtranslation,and synchronous grammars.

REFERENCES:

1. James Allen.NaturalLanguageUnderstanding.TheBenajmins/CummingsPublishingCompanyInc. 1994.ISBN 0-8053-0334-0.
2. TomMitchell.Machine Learning.McGraw Hill,1997.ISBN0070428077.
3. Cover,T.M.andJ.A.Thomas:ElementsofInformationTheory.Wiley.1991.ISBN0-471-06259-6.
4. Charniak,E.:StatisticalLanguageLearning.The MITPress.1996.ISBN0-262-53141-0.

		Credits

CourseCode	CourseName	L	T	P	C
M.Tech-CSE-205	Elective-I	3	0	0	3

Subject List:

Elective-I Subjects:

(i) Reinforcement Learning

(ii) Graph Representation Learning

(iii) Information Retrieval

(iv) Knowledge Engineering and Expert Systems

(v) Number Theory & Cryptography

Course Title:Reinforcement Learning

Prerequisites:
Familiarity with probability theory, linear algebra, and calculus.
Programming proficiency in a high-level language (e.g., Python).

UNIT I:Introduction to Reinforcement Learning
Overview of RL and its applications, Markov Decision Processes (MDPs), Value functions and Bellman equations, Exploration vs. exploitation trade-off

UNIT II: Dynamic Programming for RL: Policy evaluation and iteration, Value iteration and policy iteration, Convergence and optimality of dynamic programming methods

UNIT III: Monte Carlo Methods: Monte Carlo prediction and control, Exploring starts and importance sampling, Temporal-difference learning

UNIT IV: Temporal-Difference Learning: TD(0) and TD(n) methods, Sarsa and Q-learning algorithms, Function approximation in RL

UNIT V: Function Approximation: Linear function approximation, Nonlinear function approximation, Deep Q-Networks (DQN)

UNIT VI: Policy Gradient Methods: Policy representation and parameterization, Policy gradient theorem, REINFORCE algorithm and its variants

UNIT VII: Exploration and Exploitation: Epsilon-greedy and softmax policies, Upper confidence bound (UCB) methods, Thompson sampling

UNIT VIII: Advanced RL Algorithms: Actor-Critic methods, Trust Region Policy Optimization (TRPO), Proximal Policy Optimization (PPO)

UNIT IX: Multi-Agent Reinforcement Learning: Markov games and multi-agent settings, Nash equilibrium and correlated equilibrium, Independent Q-Learning (IQL) and other multi-agent algorithms

UNIT X: Applications: Model-based and model-free approaches, Sim-to-Real transfer in RL, Game theory and RL, AlphaGo and AlphaZero, General video game playing, RL for combinatorial optimization, RL for continuous optimization, Applications in resource allocation and scheduling and Natural Language Processing.

REFERENCES:

1. "Deep Reinforcement Learning" by Pieter Abbeel and John Schulman (online lecture notes)
2. "Reinforcement Learning: State-of-the-Art" edited by Marco Wiering and Martijn van Otterlo
3. "Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations" by Yoav Shoham and Kevin Leyton-Brown
4. Reinforcement Learning: An Introduction" by Richard S. Sutton and Andrew G. Barto
5. "Reinforcement Learning: State-of-the-Art" edited by Marco Wiering and Martijn van Otterlo
6. Research papers from top conferences (e.g., NeurIPS, ICML, ICLR, AAAI)

Course Title:Graph Representation Learning

UNIT I: Graph Terminology and Representation (8 Hours)
Graph definition, Storing Graph Information, Graph Degree, and Laplacian of Graph, Definition of learning in Graph Representation Learning, Drawback of existing graph learning models, Practice using Tensor, and Torch Geometric for defining a Graph.

UNIT II: From Convolutional Neural Network to Graph Neural Network (6 Hours)
Review of Convolution operation, Graph Convolution, Message Passing Framework

UNIT III: Introduction to Different Graph Embedding Methods (10 Hours)
Graph Embedding Problem statement, DeepWalk Algorithm, Practice with RandomWalk using karetclub library, Node2Vec Algorithm, Practice Node2Vec using Karateclub, Pytorch Geometric, GNN Motivation, Simplifying Graph Convolution Network. Practice for Graph Convolution Network using Pytorch Geometric, Graph Attention Network.

UNIT IV: Induction and Transudative Graph Embedding (10 Hours)
Review of Popular GNN Embedding Methods, Transudative and Inductive Embedding Methods, GraphSAGE

REFERENCES:

1. Graph Representation Learning, 202 by William L. Hamilton, Morgan & Clay Pool Publishers, ISBN: 9781681739649 (ebook)
2. Deep Learning on Graphs, 2021 by Yao Ma and Jiliang Tang, Cambridge University Press, ISBN: 978-1-108-83174-1 (Hardback)

Web Resource:
1. https://antoniolonga.github.io/Pytorch_geometric_tutorials/index.html

Course Title:Information Retrieval

UNIT I:

Introduction: Overview of Information Retrieval, Architecture of a Search Engine,
Acquiring Data : Crawling the Web, Document Conversion, Storing the Documents, Detecting Duplicates, Noise Detection and Removal.
Processing Text: Text Statistics, Document Parsing, Tokenizing, Stopping, Stemming, Phrases, Document Structure, Link Extraction, More detail on Page Rank, Feature Extraction and Named Entity Recognition, Internationalization.

UNIT II:

Ranking with Indexes Abstract Model of Ranking, Inverted indexes, Map Reduce, Query Processing: Document-at-a-time evaluation, Term-at-a-time evaluation, Optimization techniques, Structured queries, Distributed evaluation, Caching.
Queries and Interfaces: Information Needs and Queries, Query Transformation and Refinement: Stopping and Stemming Revisited, Spell Checking and Query Suggestions, Query Expansion, Relevance Feedback, Context and Personalization. Displaying the Results: Result Pages and Snippets, Advertising and Search, Clustering the Results; Translation; User Behavior Analysis.

UNIT III:

Retrieval Models: Overview of Retrieval Models; Boolean Retrieval, The Vector Space Model. Probabilistic Models: Information Retrieval as Classification, The BM25 Ranking Algorithm. Ranking based on Language Models: Query Likelihood Ranking, Relevance Models and Pseudo-Relevance Feedback. Complex Queries and Combining Evidence: The Inference Network Model, The Galago Query Language. Models for Web search, Machine Learning and Information Retrieval: Learning to Rank (Le ToR), Topic Models

UNIT IV:

Evaluating Search Engines: Test collections, Query logs, Effectiveness Metrics: Recall and Precision, Averaging and interpolation, focusing on the top documents. Training, Testing, and Statistics: Significance tests, setting parameter values
Classification and Clustering

UNIT V:

Social Search: Networks of People and Search Engines: User tagging, searching within Communities, Filtering and recommending, Meta search. Beyond Bag of Words: Feature-Based Retrieval Models, Term Dependence Models, Question Answering, Pictures, Pictures of Words, etc., XML Retrieval, Dimensionality Reduction and LSI

TEXTBOOKS

1. Introduction to Information Retrieval. Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schuetze, Cambridge University Press, 2007.

REFERENCES:

1. Search Engines: Information Retrieval in Practice. Bruce Croft, Donald Metzler, and Trevor Strohman, Pearson Education, 2009.
2. Modern Information Retrieval. Baeza-Yates Ricardo and BerthierRibeiro-Neto. 2nd edition, Addison-Wesley, 2011.

Course Title:Knowledge Engineering & Expert Systems

UNIT I:
The nature of Expert Systems Types of applications of Expert Systems Relationship of Expert Systems to Artificial Intelligence and to Knowledge-Based Systems. The nature of expertise
Distinguishing features of Expert Systems. Benefits of using an Expert System Choosing an application.

UNIT II:
Theoretical Foundations What an expert system is; how it works and how it is built. Basic forms of inference: abduction; deduction; induction.

UNIT III:
The representation and manipulation of knowledge in a computer; Rule-based representations (with backward and forward reasoning); logic-based representations (with resolution refutation); taxonomies; meronomies; frames (with inheritance and exceptions); semantic and partitioned nets (query handling).

UNIT IV:
Basic components of an expert system; Generation of explanations; Handling of uncertainties; Truth Maintenance Systems; Expert System Architectures; An analysis of some classic expert systems; Limitations of first generation expert systems; Deep expert systems; Co-operating expert systems and the blackboard model.

UNIT V:
Building Expert Systems Methodologies for building expert systems: knowledge acquisition and elicitation; formalisation; representation and evaluation. Knowledge Engineering tools, Case Study.

TEXTBOOKS:
1. P Jackson, Introduction to Expert Systems, Addison Wesley, 1990 (2nd Edition).

REFERENCES:
1. Elaine Rich, Kevin Knight, Artificial Intelligence, McGraw-Hill, Inc, 1991 (2nd Edition).
2. Jackson. Jean-Louis Lauriere, Problem Solving and Artificial Intelligence, Prentice Hall, 1990.

Course Title:Number Theory and Cryptography

UNIT I:

Cryptography, Cryptanalysis and Brute-Force Attack, Basic introduction Cryptography, Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques. Induction and recursion; number systems; prime and composite numbers; divisibility theory, Divisibility and Unique Factorization and the Euclidean algorithm; congruence; introduction to finite fields, and examples,

UNIT II:

Block ciphers, Attacks on block ciphers, Block Cipher Principles, The Data Encryption Standard (DES), Block Cipher Design Principles, Block cipher modes of operation, The Euclidean Algorithm, Finite Fields of the Form GF(2n), Advanced Encryption Standard (AES), Stream Ciphers, RC4.

UNIT III:

Modular Arithmetic, Arithmetic modulo primes, Euclid's Algorithm, The Theorems of Fermat and Euler, Testing for Primality, The Chinese Remainder Theorem, Building Blocks for Cryptography, Introduction to Public Key Cryptography, The RSA Algorithm, Primitive Roots and Discrete Logarithms, Diffie-Hellman Key Exchange, Elliptic Curve Cryptography. Elgamal Cryptographic systems, Digital signatures: definitions and applications

UNIT IV:

Introduction to Hash Functions, Cryptographic Hash Functions, Hash Functions Based on Cipher Block Chaining, Collision resistant hashing, Message integrity: definition and applications, Secure Hash Algorithm (SHA), SHA-3. Application of Cryptographic Hash Functions

UNIT V:

Introduction of decentralization in security; Block Chaining; Bitcoin; Some other new techniques in Cryptography; Zero knowledge protocols; Cryptography in the age of quantum computers

REFERENCES:

1. Stallings, William. Cryptography and network security, 4/E. Pearson Education India, 2006.
2. D. Stinson Cryptography, Theory and Practice (Third Edition).
3. Handbook of Applied Cryptography by A. Menezes, P. Van Oorschot, S. Vanstone.
4. An Introduction to Number Theory with Cryptography by J.S. Kraft & L.C. Washington
5. Numbers, Groups, and Cryptography by G. Savin.
6. Introduction to Modern Cryptography (2nd edition) by J. Katz and Y. Lindell.