Faculty of Science and Technology

Savitribai Phule Pune University

Maharashtra, India

http://unipune.ac.in

Honours* in Artificial Intelligence and Machine Learning

Board of Studies

(Computer Engineering)

(with effect from A.Y. 2020-21)

Savitribai Phule Pune University

Honours* in Artificial Intelligence and Machine Learning

With effect from 2020-21

Year & Semester	Course Code	Course Title	Teaching Scheme Hours / Week			Examination Scheme and Marks						Credit Scheme		
			Theory	Tutorial	Practical	Mid-Semester	End-Semester	Term work	Practical	Presentation	Total Marks	Theory / Tutorial	Practical	Total Credit
TE & V	310301	Computational Statistics	04	--	--	30	70	--	--	--	100	04	--	04
	310302	Computational Programming Laboratory	--	--	02	--	--	50	--	--	50	--	01	01
		Total	04	-	02	100		50	-	-	150	04	01	05
Total Credits =05														
TE & VI	310303	Artificial Intelligence	04	--	--	30	70	--	--	--	100	04	--	04
		Total	04	-	-	100		-	-	-	100	04	-	04
Total Credits =04														
BE & VII	410301	Machine Learning	04	--	--	30	70	--	--	--	100	04	--	04
	410302	Machine Learning Laboratory	--	--	02	--	--	50	--	--	50	--	01	01
		Total	04	-	02	100		50	-	-	150	04	01	05
Total Credits =05														
BE & VIII	410303	Soft Computing and Deep Learning	04	-	--	30	70	--	--	--	100	04	--	04
	410304	Seminar	--	02	--	--	--	-	--	50	50	02	--	02
		Total	04	-	02	100		-	--	50	150	06	-	06
Total Credits =06														

Total Credit for Semester V+VI+VII+VIII = 20

*** <u>To be offered as Honours for Major Disciplines as–</u>**

1. Computer Engineering
2. Electronics and Telecommunication Engineering
3. Electronics Engineering
4. Information Technology

<u>For any other Major Disciplines which is not mentioned above, it may be offered as Minor Degree.</u>

Reference: https://www.aicte-india.org/sites/default/files/APH%202020_21.pdf / page 99-100

Savitribai Phule Pune University
Honours* in Artificial Intelligence and Machine Learning
Third Year of Engineering (Semester V)
310301: Computational Statistics

Teaching Scheme	Credit Scheme	Examination Scheme and Marks
Lecture: **04 Hours/Week**	**04**	**Mid_Semester(TH): 30 Marks** **End_Semester(TH): 70 Marks**

Companion Course : **Computational Statistics Laboratory**

Course Objectives:

To introduce several statistical techniques found to be serving as tools even today in the development of machine learning and artificial intelligence based computer algorithms.

- To imbibe strong foundation of statistics in students for implementation in computation.
- To understand modern computational methods used in statistics.
- To get detailed approach of simulation, estimation and visualization of statistical data
- To understand the role of computation as a tool of discovery in data analysis.
- To be able to appropriately apply computational methodologies to real world statistical problems.
- To learn the data processing techniques required to get applied on machine learning algorithms.

Course Outcomes:

On completion of the course, learner will be able to–

- **Identify** the suitable method of statistics on the given data to solve the problem of any heuristic approach of prediction.
- **Apply** appropriate statistical concepts and skills to solve problems in both familiar and unfamiliar situations including those in real-life contexts.
- **Design and analyze** real world engineering problems by applying various statistical modeling techniques.
- **Formulate** suitable statistical method required as pre-processing technique for finding the solution of machine learning algorithm.
- **Model and solve** computing problem using correlation, and resampling using appropriate statistics algorithms.

#Exemplar/Case Studies- Elaborated examples/Case Studies are included at the end of each unit to explore how the learned topics apply to real world situations and need to be explored so as to assist students to increase their competencies, inculcating the specific skills, building the knowledge to be applicable in any given situation along with an articulation. One or two sample exemplars or case studies are included for each unit; instructor may extend the same with more. **Exemplar/Case Studies** may be assigned as self-study by students and to be excluded from theory examinations.

Course Contents

Unit I	Introduction to Statistics	(07 Hours)
What is statistics, Statistical Data- Categorical, Numerical (Continuous), Univariate and Bivariate Analysis, Mean, Median, Mode, Standard Deviation, Harmonic Mean, Data Visualization-Line, Scatter, Box plots, Histogram, Statistical Thinking.		
#Exemplar/ Case Studies	Know about the great statistician- Ronald Fisher	
Unit II	**Distributions**	**(9 Hours)**

Probability Distributions, Characterizing a Distribution, Discrete Distributions, Normal Distributions, Continuous Distributions Derived from the Normal Distribution, Poisson Distribution, Other Continuous distributions- Lognormal, Weighbull, Exponential, Uniform.		
#Exemplar/ Case Studies	Know about the great statistician and father of Indian statistical institute- Praful Chandra Mahanalobis	
Unit III	**Hypothesis Tests and Statistical Tests**	**(08 Hours)**
Typical Analysis procedures, Hypothesis Concept, Errors, p-Value, and Sample Size, Confusion Matrix, Sensitivity and Specificity, ROC-AUC Curve, Test on Numerical Data- Distribution of a Sample Mean, Comparison of Two Groups, Comparison of Multiple Groups		
#Exemplar/ Case Studies	Study brief history of Statistics	
Unit IV	**Statistical Methods**	**(08 Hours)**
Standard Deviation, Normalization- Feature Scaling, Min-Max scaling, Bias, Variance, Regularization, Ridge Regression, Lasso Regression, Cross Validation Techniques- K-fold, LOOCV, Stratified K-fold, Grid Search CV, CV Error		
#Exemplar/ Case Studies	Euclid's Elements	
Unit V	**Statistical Processing**	**(08 Hours)**
Dimensionality Reduction Techniques- Principal Component Analysis, Discriminant Analysis, Feature Selection- Chi2 square method, Variance Threshold, Recursive Feature Elimination, Outliers detection methods, Resampling-Random, under-sampling and over re-sampling		
#Exemplar/ Case Studies	Study about Anomalies	
Unit VI	**Statistical Modeling**	**(08 Hours)**
Linear Regression models, Correlation coefficient, Rank Correlation, Residual Error, Mean Square Error, RMSE, Multilinear Regression, Polynomial Features, Gradient Descent, Logistic Regression, Bayesian Statistics, Bayes' Theorem, Monte Carlo Method		
#Exemplar/ Case Studies	Study Biography of Thomas Bayes	

Learning Resources

Text Books:

- Thomas Haslwanter, "An Introduction to Statistics with Python with Applications in the Life Sciences", Springer International Publishing Switzerland 2016, ISBN 978-3-319-28315-9, ISBN 978-3-319-28316-6 (eBook)
- Allen B. Downey, "Think Stats", Second Edition, O'Reilly Media, ISBN: 978-1-491-90733-7

Reference Books:

- Thomas Haslwanter, "An Introduction to Statistics with Python with Applications in the Life Sciences", Springer International Publishing Switzerland 2016, ISBN 978-3-319-28315-9, ISBN 978-3-319-28316-6 (eBook)
- Peter Bruce and Andrew Bruce, "Practical Statistics for Data Scientists", First Edition, O'Reilly Media, ISBN-978-1-491-95296-2
- Allen B. Downey, "Think Stats", Second Edition, O'Reilly Media, ISBN: 978-1-491-90733-7
- José Unpingco, "Python for Probability, Statistics, and Machine Learning", Springer International Publishing Switzerland, ISBN 978-3-319-30715-2, DOI 10.1007/978-3-319-30717-6, ISBN 978-3-319-30717-6 (eBook)
- Claus Weihs, Olaf Mersmann, Uwe Ligges, "Foundations of Statistical Algorithms", CRC Press, ISBN-978-1-4398-7887-3 (eBook - PDF)

e-Books:

- http://file.allitebooks.com/20151204/Foundations%20of%20Statistical%20Algorithms.pdf
- http://onlinestatbook.com/Online_Statistics_Education.pdf
- https://upload.wikimedia.org/wikipedia/commons/8/82/Statistics.pdf
- http://cnx.org/content/col10522/1.38/pdf
- http://www.greenteapress.com/thinkstats/thinkstats.pdf

MOOC/ Video Lectures available at:

- https://www.udemy.com/course/introduction-to-bayesian-statistics/ (Free Course)
- https://www.udacity.com/course/intro-to-statistics--st101# (Free Course)
- https://nptel.ac.in/courses/111/105/111105090/
- https://nptel.ac.in/courses/111/105/111105077/

Savitribai Phule Pune University
Honours* in Artificial Intelligence and Machine Learning
Third Year of Engineering (Semester V)
310302: Computational Programming Laboratory

Teaching Scheme	Credit Scheme	Examination Scheme and Marks
Practical:2 Hours/Week	01	Term work:50 Marks

Guidelines for Laboratory Conduction

- **Lab Assignments:** Following is list of suggested laboratory assignments for reference. Laboratory Instructors may design suitable set of assignments for respective course at their level. Beyond curriculum assignments and mini-project may be included as a part of laboratory work. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. The Inclusion of few optional assignments that are intricate and/or beyond the scope of curriculum will surely be the value addition for the students and it will satisfy the intellectuals within the group of the learners and will add to the perspective of the learners. For each laboratory assignment, it is essential for students to draw/write/generate flowchart, algorithm, test cases, mathematical model, Test data set and comparative/complexity analysis (as applicable). Batch size for practical and tutorial may be as per guidelines of authority.
- **Term Work–**Term work is continuous assessment that evaluates a student's progress throughout the semester. Term work assessment criteria specify the standards that must be met and the evidence that will be gathered to demonstrate the achievement of course outcomes. Categorical assessment criteria for the term work should establish unambiguous standards of achievement for each course outcome. They should describe what the learner is expected to perform in the laboratories or on the fields to show that the course outcomes have been achieved. It is recommended to conduct internal monthly practical examination as part of continuous assessment.
- **Assessment:** Students' work will be evaluated typically based on the criteria like attentiveness, proficiency in execution of the task, regularity, punctuality, use of referencing, accuracy of language, use of supporting evidence in drawing conclusions, quality of critical thinking and similar performance measuring criteria.
- **Laboratory Journal-** Program codes with sample output of all performed assignments are to be submitted as softcopy. Use of DVD or similar media containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Submission of journal/ term work in the form of softcopy is desirable and appreciated.

Suggested list of assignments
(Use suitable programming language/Tool for implementation)

Sr.	Assignment statement
1	Compute Estimators of the main statistical measures like Mean, Variance, Standard Deviation, Covariance, Correlation and Standard error with respect to any example. Display graphically the distribution of samples.
2	Plot the Normal Distribution for class test result of a particular subject. Identify the Skewness and Kurtosis

3	Load the dataset: birthwt Risk Factors Associated with Low Infant Birth Weight at https://raw.github.com/neurospin/pystatsml/master/datasets/birthwt.csv 1. Test the association of mother's (bwt) age and birth weight using the correlation test and linear regeression. 2. Test the association of mother's weight (lwt) and birth weight using the correlation testand linear regeression. 3. Produce two scatter plot of: (i) age by birth weight; (ii) mother's weight by birth weight. Elaborate the Conclusion
4	Apply Basic PCA on the iris dataset. The data set is available at: https://raw.github.com/neurospin/pystatsml/master/datasets/iris.csv • Describe the data set. Should the dataset been standardized? • Describe the structure of correlations among variables. • Compute a PCA with the maximum number of components .• Compute the cumulative explained variance ratio. Determine the number of components K by your computed values. • Print the K principal components directions and correlations of the K principal compo-nents with the original variables. Interpret the contribution of the original variables into the PC. • Plot the samples projected into the K first PCs. • Color samples by their species.
5	Perform clustering of the iris dataset based on all variables using Gaussian mixture models. Use PCA to visualize clusters.

Savitribai Phule Pune University
Honours* in Artificial Intelligence and Machine Learning
Third Year of Engineering (Semester VI)
310303: Artificial Intelligence

Teaching Scheme	Credit Scheme	Examination Scheme and Marks
Lecture: 04 Hours/Week	04	Mid_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisite: Discrete Mathematics, Any Programming Knowledge (Python/Matlab/Java), Machine Learning.

Companion Course : ---

Course Objectives:

The basic objectives of this course is

- To understand the basic concept of AI, strength and weakness of problem solving and search
- To study about various heuristic and game search algorithms
- To know about basic concepts of knowledge and reasoning, NLP and Machine Learning
- To know about various Expert System tools and applications
- To know expert system tools and applications

Course Outcomes:

On completion of the course, learner will be able to–

- Evaluate Artificial Intelligence (AI) methods and describe their foundations.
- Analyze and illustrate how search algorithms play vital role in problem solving, inference, perception, knowledge representation and learning
- Demonstrate knowledge of reasoning and knowledge representation for solving real world problems
- Illustrate the construction of learning and expert system
- Discuss current scope and limitations of AI and societal implications.

Course Contents

Unit I	Introduction to AI	(08 Hours)

Definitions – Foundation and History of AI, Evolution of AI - Applications of AI, Classification of AI systems with respect to environment. Artificial Intelligence vs Machine learning, Statistical Analysis: Relationship between attributes: Covariance, Correlation Coefficient, Chi Square. Intelligent Agent: Concept of Rationality, nature of environment, structure of agents.

Unit II	Problem Solving	(08 Hours)

Heuristic Search Techniques: Generate-and-Test; Hill Climbing; Properties of A* algorithm, Best-first Search; Problem Reduction. **Constraint Satisfaction problem:** Interference in CSPs; Back tracking search for CSPs; Local Search for CSPs; structure of CSP Problem. **Beyond Classical Search:** Local search algorithms and optimization problem, local search in continuous spaces, searching with nondeterministic action and partial observation, online search agent and unknown environments.

Unit III	Knowledge and Reasoning	(08 Hours)

Knowledge and Reasoning: Building a Knowledge Base: Propositional logic, first order Logic, situation calculus. Theorem Proving in First Order Logic, Planning, partial order planning. **Uncertain Knowledge and Reasoning**, Probabilities, Bayesian Networks. Probabilistic reasoning over time: time and uncertainty, hidden Markova models, Kalman filter, dynamic bayesian network, keeping track of many objects

Unit IV	Learning	(07 Hours)

Learning from examples: Overview of different forms of learning, Supervised learning, Unsupervised learning, Learning Decision Trees, regression and classification with linear model, SVM, Ensemble learning, Reinforcement learning. Artificial neural network

Unit V	Game	(06 Hours)

Search under adversarial circumstances. Optimal decision in game, minimax algorithm, alpha-beta pruning, games with an element of chance, imperfect real time decision, stochastic games, partially observable games, stat of art game program, alternative approaches

Unit VI	Expert Systems	(06 Hours)

Introduction to Expert Systems- Inference - Forward chaining - Backward chaining - Languages and tools - Explanation facilities - Knowledge acquisition. **Applications: Natural Language Processing:** General framework for text processing. C**ase Study:** Sentiment Analysis. **Computer Vision:** General framework for CV application. **Case Study:** Object Recognition

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Learning Resources

Text Books:

- Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall
- J. Gabriel, Artificial Intelligence: Artificial Intelligence for Humans (Artificial Intelligence, Machine Learning), Create Space Independent Publishing Platform, First edition , 2016

Reference Books:

- Introduction to Artificial Intelligence & Expert Systems, Dan W Patterson, PHI.,2010 2. S Kaushik, Artificial Intelligence, Cengage Learning, 1st ed.2011
- Ric, E., Knight, K and Shankar, B. 2009. Artificial Intelligence, 3rd edition, Tata McGraw Hill.
- Luger, G.F. 2008. Artificial Intelligence -Structures and Strategies for Complex Problem Solving, 6th edition, Pearson
- Alpaydin, E. 2010. Introduction to Machine Learning. 2nd edition, MIT.

Savitribai Phule Pune University
Honors* in Artificial Intelligence and Machine Learning
Fourth Year of Engineering (Semester VII)
410301: Machine Learning

Teaching Scheme	Credit Scheme	Examination Scheme and Marks
Lecture: 04 Hours/Week	**04**	**Mid_Semester(TH): 30 Marks** **End_Semester(TH): 70 Marks**

Prerequisites: Mathematics/Statistics

Companion Course : ---

Course Objectives:

- To understand the basic concepts machine Learning and apply different dimensionality reduction techniques
- To optimize the different linear methods of regression and classification
- To interpret the different supervised classification methods of support vector machine and tree based models
- To learn the different models of neural network for solving non linear functions
- To acquire the knowledge of different generative models through unsupervised learning
- To explain the different graphical and Hidden Markov models of learning

Course Outcomes:

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

- **CO1: Recognize** the characteristics of machine learning that makes it useful to real-world problems and **apply** different dimensionality reduction techniques. **L2**
- **CO2: Use** different linear methods for regression and classification with their **optimization** through different regularization techniques. **L3**
- **CO3: Apply** the different supervised learning methods of support vector machine and tree based models. **L3**
- **CO4: Select** the appropriate type of neural network architecture and **apply** for learning non-linear functions. **L5**
- **CO5: Distinguish** different generative models through unsupervised learning **. L4**
- **CO6: Draw** the inferences from the different graphical and hidden Markov models. **L4**

Course Contents

Unit I	Introduction	(08 Hours)

Introduction to Machine Learning, Examples of Machine Learning Applications, Learning Types

Supervised Learning -Learning a Class from Examples, Vapnik-Chervonenkis (VC) Dimension, Probably Approximately Correct (PAC) Learning,Noise, Learning Multiple Classes, Regression, Model Selection and Generalization, Dimensions of a Supervised Machine

Learning Algorithm

Dimensionality Reduction- Introduction,Subset Selection, Principal Components Analysis, Factor Analysis, Multidimensional Scaling, Linear Discriminant Analysis,Isomap, Locally Linear Embedding

Unit II	Linear Methods for Regression	(08 Hours)

Introduction, Linear Regression Models and Least Squares, Subset Selection, Shrinkage Methods-Ridge Regression, Lasso Regression, Least Angle Regression, Methods Using Derived Input Directions-Principal Components Regression, Partial Least Squares, A Comparison of the Selection and Shrinkage Methods , Multiple Outcome Shrinkage and Selection, More on the Lasso and Related Path Algorithms, Logistic Regression-Fitting Logistic Regression Models, Quadratic Approximations and Inference, L1 Regularized Logistic Regression

Unit III	Support Vector Machines and Tree-Based Models	(08 Hours)

SVM-Introduction to SVM, The Support Vector Classifier, Support Vector Machines and Kernels- Computing the SVM for Classification, The SVM as a Penalization Method, Function Estimation and Reproducing Kernels, SVMs and the Curse of Dimensionality, A Path Algorithm for the SVM Classifier, Support Vector Machines for Regression, Regression and Kernels

Tree Based Methods-Regression Trees, Classification Trees, **Random Forests**- Definition of Random Forests, Details of Random Forests- Out of Bag Samples, Variable Importance, Proximity Plots, Random Forests and Overfitting, Analysis of Random Forests-Variance and the De-Correlation Effect, Bias, Adaptive Nearest Neighbors

Unit IV	Multilayer Perceptrons	(08 Hours)

Introduction-Understanding the Brain, Neural Networks as a Paradigm for Parallel Processing, The Perceptron, Training a Perceptron, Learning Boolean Functions, Multilayer Perceptrons, MLP as a Universal Approximator ,**Backpropagation Algorithm-**Nonlinear Regression,Two-Class Discrimination, Multiclass Discrimination, Multiple Hidden Layers, **Training Procedures**-improving Convergence, Overtraining, Structuring the Network,Tuning the Network Size, Bayesian View of Learning, Dimensionality Reduction, **Learning Time**-Time Delay Neural Networks, Recurrent Networks, **Regularization in Neural Networks,** Bayesian Neural Networks

Unit V	Unsupervised Learning	(08 Hours)

Introduction**,** **Association Rules**-Market Basket Analysis, The Apriori Algorithm, Unsupervised as Supervised Learning,Generalized Association Rules, **Cluster Analysis**-Proximity Matrices**,**

Clustering Algorithms-K-mean, Gaussian Mixtures as Soft K-means Clustering, Example: Human Tumor Microarray Data, Vector Quantization, K-medoids, Hierarchical Clustering, **Self-Organizing Maps, PCA-Spectral Clustering**

Unit VI	Hidden Markov and Graphical Models	(08 Hours)

Hidden Markov Models-Introduction, Discrete Markov Processes,Hidden Markov

Models,Three Basic Problems of HMMs,Evaluation Problem,Finding the State Sequence,Learning Model Parameters,Continuous Observations,The HMM with Input,Model Selection in HMM

Graphical Models-Introduction,Canonical Cases for Conditional Independence,Example Graphical Models-Naive Bayes' Classifier, Hidden Markov Model,Linear Regression, d-Separation,Belief Propagation-Chains,Trees,olytrees,Junction Trees, Undirected Graphs: Markov Random Fields,Learning the Structure of a Graphical Model,Influence Diagrams

Learning Resources

Text Books:

- Introduction to Machine Learning Edition 2, by Ethem Alpaydin
- The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
- Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.

Reference Books:

- Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
- Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.
- Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.
- Understanding Machine Learning, Shai Shalev-Shwartz and Shai Ben-David, Published 2014 by Cambridge University Press.

e-Books:

- **https://web.stanford.edu/~hastie/ElemStatLearn/**
- **http://www.springer.com/in/book/9780387310732**
- **http://www.cs.huji.ac.il/~shais/UnderstandingMachineLearning/**
- **https://www.cs.cornell.edu/jeh/book.pdf**

MOOC/ Video Lectures available at:

- https://nptel.ac.in/courses/106/106/106106139/
- https://nptel.ac.in/courses/106/106/106106202/
- https://nptel.ac.in/courses/106/106/106106198/
- https://nptel.ac.in/courses/106/105/106105152/
- https://nptel.ac.in/courses/106/106/106106213/
- https://www.coursera.org/learn/machine-learning

Savitribai Phule Pune University
Honors* in Artificial Intelligence and Machine Learning
Fourth year of Engineering (Semester VII)

410302: Machine learning Laboratory

Teaching Scheme	Credit Scheme	Examination Scheme and Marks
Practical: 01 Hours/Week	**01**	**Term work: 50 Marks**

Guidelines for Laboratory Conduction

- **Lab Assignments:** Following is list of suggested laboratory assignments for reference. Laboratory Instructors may design suitable set of assignments for respective course at their level. Beyond curriculum assignments and mini-project may be included as a part of laboratory work. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. The Inclusion of few optional assignments that are intricate and/or beyond the scope of curriculum will surely be the value addition for the students and it will satisfy the intellectuals within the group of the learners and will add to the perspective of the learners. For each laboratory assignment, it is essential for students to draw/write/generate flowchart, algorithm, test cases, mathematical model, Test data set and comparative/complexity analysis (as applicable). Batch size for practical and tutorial may be as per guidelines of authority.
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- **Assessment:** Students' work will be evaluated typically based on the criteria like attentiveness, proficiency in execution of the task, regularity, punctuality, use of referencing, accuracy of language, use of supporting evidence in drawing conclusions, quality of critical thinking and similar performance measuring criteria.
- **Laboratory Journal-** Program codes with sample output of all performed assignments are to be submitted as softcopy. Use of DVD or similar media containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Submission of journal/ term work in the form of softcopy is desirable and appreciated.

Sr. No	Suggested List of assignment
1	Creating & Visualizing Neural Network for the given data. (Use python) Note: download dataset using Kaggal. Keras, ANN visualizer, graph viz libraries are required.
2	Recognize optical character using ANN
3	Implement basic logic gates using Hebbnet neural networks
5	Exploratory analysis on Twitter text data Perform text pre-processing, Apply Zips and heaps law, Identify topics
4	Text classification for Sentimental analysis using KNN Note: Use twitter data
6	Write a program to recognize a document is positive or negative based on polarity words using suitable classification method.

Savitribai Phule Pune University
Honours* in Artificial Intelligence and Machine Learning
Fourth Year of Engineering (Semester VIII)
410303: Soft Computing and Deep Learning

Teaching Scheme	Credit Scheme	Examination Scheme and Marks
Lecture: 04 Hours/Week	04	Mid_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisites: Knowledge of basic computing techniques

Companion Course : ---

Course Objectives:

The basic objectives of this course is

- To understand different soft computing techniques and its applications.
- To introduce students to understand, explain, and apply the fuzzy set and fuzzy logic in real life applications
- To understand the use of genetic algorithm to design and develop various applications
- To understand and acquire knowledge of artificial neural network and its different learning and computing mechanism
- To study how to model complex problems using deepl learning network.
- To learn and and design a solution by applying the principles of CNN and RNN to solve diversified complex problem

Course Outcomes:

On completion of the course, learner will be able to–

CO 1: Formulate the real life problem by mapping different soft computing techniques

CO 2: Apply principles of Soft computing to solve problmes in varieties of application domains.

CO 3: Design and analyze real world engineering problems by applying genetic algorithm and its basic principles

CO 4: Specify, manipulate and apply CNN and RNN to solve diversified complex real world problems

CO 5: Calculate the minimum weight of the neural network to find the optimized solution of a problem

CO6: Model and solve computing problem using artificial neural network, fuzzy systems and genetic algorithm

Course Contents

Unit I	Basics of Soft Computing	(06 Hours)

Evolution of Computing, Inroduction of Soft Computing, Hard Computing and Soft Computing, Requirement of Soft Computing, Charactersetics of Soft Computing, Major areas of Soft Computing, Applications of Soft Computing.

Unit II	Fuzzy Logic	(06 Hours)

Fuzzy Set theory, Fuzzy set versus Crisp set, Membership function, Operations on Fuzzy set, Fuzzy Relation, Fuzzification and Defuzzification, Minmax Composition, Fuzzy Logic, Fuzzy Rule based systems, Predicate logic, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification, Fuzzy controllers, Application of Fuzzy systems(Real life)

Unit III	Genetic Algorithm	(06 Hours)

Evolution of Genetic Algorithms (GA), Basic GA framework and different GA architectures, GA operators: Crossover, Selection, Mutation, Fitness function, Convergence Working

Principle, Vncoding methods , Bit wise operation in GA, Multi-level Optimization, Applications of GA in Machine Learning.

Unit IV	Neural Network	(06 Hours)

Introduction, Learning rules and activation functions, Single layer and multilayer Perceptrons , Feed forward and Back propagation networks, Architecture of Backpropagation (BP) Networks, Backpropagation Learning mechanism, Types of Artificial Neural Network(ANN), Introduction to Associative Memory, Adaptive Resonance, Self Organizing Map, Recent applications (real life)

Unit V	Deep Learning I	(06 Hours)

Introduction, Why to go deep ?, Architecture of Deep Network, Restricted Boltzman Machines, Deep belief Network, Tensor Flow, Deep Learning libraries, Deep Learning platform, Theano, Caffe, Deep Learning Use Cases.

Unit VI	Deep Learning II	(06 Hours)

Introduction to Convolution Neural Network(CNN), Properties of CNN representations: invertibility, stability, Convolution layers invariance, Residual Nets, Scattering networks, Group formalism, Applications of CNN.

Introduction to Recurrent Neural Network(RNN), Sequential processing LSTM, Language Modeling, Image Captioning, Applications of RNN.

Learning Resources

Text Books:

- Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI, 2007.
- An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press, 2000.
- Fuzzy Logic: A Pratical approach, F. Martin, , Mc neill, and Ellen Thro, AP Professional, 2000.
- Soft Computing, D. K. Pratihar, Narosa, 2008

Home

Reference Books:

- Fuzzy Logic with Engineering Applications (3rd Edn.), Timothy J. Ross, Willey, 2010
- Neuro-Fuzzy and soft Computing, J.-S. R. Jang, C.-T. Sun, and E. Mizutani, PHI Learning, 2009
- Foundations of Neural Networks, Fuzzy Systems, and Knowldge Engineering, Nikola K. Kasabov, MIT Press, 1998
- Genetic Algorithms In Search, Optimization And Machine Learning, David E. Goldberg, Pearson Education, 2002
- Neural Networks and Learning Machines, (3rd Edn.), Simon Haykin, PHI Learning, 2011.

e-Resources:

- https://cse.iitkgp.ac.in/~dsamanta/courses/sca/index.html
- http://www.musaliarcollege.com/e-Books/CSE/introduction-to-soft-computing%20(1).pdf
- http://www.deeplearningbook.org/
- http://deeplearning.net/tutorial/deeplearning.pdf
- http://www.dkriesel.com/en/science/neural_networks

MOOC/ Video Lectures available at:

- https://nptel.ac.in/courses/106/105/106105173/
- https://nptel.ac.in/courses/117/105/117105084/
- https://nptel.ac.in/courses/127/105/127105006/

Savitribai Phule Pune University
Honours* in Artificial Intelligence and Machine Learning
Fourth Year of Engineering (Semester VIII)
410304: Seminar

Teaching Scheme	Credit Scheme	Examination Scheme and Marks
Practical: 02 Hours/Week	**02**	**Presentation: 50 Marks**

Course Objectives:

- To train the student to independently search, identify and study important topics in computer science.
- To develop skills among students to study and keep themselves up to date of the technological developments taking place in computer science
- To expose students to the world of research, technology and innovation.

Course Outcomes:

On completion of the course, student will be able to

- To train the student to independently search, identify and study important topics in computer science.
- To develop skills among students to study and keep themselves up to date of the technological developments taking place in computer science.
- To expose students to the world of research, technology and innovation

Guidelines for Seminar:

- The department will assign an internal guide under which students shall carry out Hons. seminar work
- In order to select a topic for Hons. Seminar, the student shall refer to various resources like books, magazines, scientific papers, journals, the Internet and experts from industries and research institutes
- The topic selected for Hons. Seminar by the students will be scrutinized and if found suitable, shall be approved by the internal guide
- Student should also explore the tools and technologies available for implementation of selected topic. Student should implement/ simulate the seminar work partially/ fully for enhancing the practical skill set on topic.
- Student shall submit the progress of his/her Hons. Seminar work to the internal guide.
- The student shall prepare a REPORT on the work done on Hons. Seminar and submit it at the time of presentation.

Evaluation of IT Seminar Work

- During the seminar work, its progress will be monitored, by the internal guide.
- At the end of seminar work, copy of Hons. Seminar Report should be prepared and submitted to department.
- End Examination shall be based on the Report, technical content and Presentation.
- **Guidelines for Assessment**: Panel of staff members along with a guide would be assessing the seminar work based on these parameters-Topic, Contents and Presentation, implementation, regularity, Punctuality and Timely Completion, Question and Answers, Report, Paper presentation/Publication, Attendance and Active Participation.

References:

1. Rebecca Stott, Cordelia Bryan, Tory Young, “Speaking Your Mind: Oral Presentation and Seminar Skills (Speak-Write Series)”, Longman, ISBN-13: 978-0582382435
2. Johnson-Sheehan, Richard, “Technical Communication”, Longman. ISBN 0-321-11764-6