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POST GRADUATE PROGRAMME IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Work Integrated
Learning Programmes

BITS Pilani
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Index

Programme Curriculum

Post Graduate Programme in Artificial Intelligence and Machine Learning

According to the recent LinkedIn's Emerging Jobs report, Artificial Intelligence had a significant presence in the top emerging jobs in 2018. AI was one of the fastest growing skills on LinkedIn and recorded a 190% global increase in demand between 2015-2017.

Furthermore, a report from The World Economic Forum predicts that the growth of artificial intelligence could create 58 million net new jobs in the next few years. The future will be built on Artificial Intelligence and Machine Learning. Are you ready to be a part of it?

To remain ahead of the curve, technology professionals need to have the right combination of knowledge and skills. Having a solid academic foundation in the core concepts of AI and ML, along with a deep understanding of their applications will enable professionals to stay relevant in the rapidly changing ecosystem of the technology industry.

The BITS Pilani Post Graduate Programme in Artificial Intelligence and Machine Learning is an 11-month programme designed for technology professionals like you, and can be pursued without taking a career break. The programme focuses on building skills that will enable you fo a rewarding career in this high-growth domain.

The programme has a robust pedagogy and uses Campus Immersion, Digital Learning, Faculty Interactions, Industry Guest Lectures, Peer Learning to enable technology professionals to master core concepts and skills needed for a successful career in this exciting domain.

Who should Apply?

The programme is designed for technology professionals who wish to advance their career as a specialist in the field of Artificial Intelligence and Machine Learning. Professionals who wish to transition to roles such as Data Scientist, Machine Learning Engineer, AI Product Manager, Data Engineer, and Applied ML Scientist should consider applying to this programme.

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The career scope

According to a Gartner report, AI will create **2.3 million jobs.**

▶ The global machine learning market is expected to grow from **$1.41B in 2017** to **$8.81B by 2022.**

From 2015 to 2018, job postings for Machine Learning Engineers grew by **334%.**

▶ Worldwide revenues for cognitive and AI systems will increase from **$12.5B in 2017** to more than **$46B in 2020.**

More than **50,000 data science** and **machine learning jobs** are currently vacant due to the dearth of qualified talent.

▶ **75%** of Indian companies have already started investing or are going to invest in **machine learning** and **data science.**

Machine Learning Engineers are the highest paid tech professionals behind only Computer Vision Engineers reports Indeed.
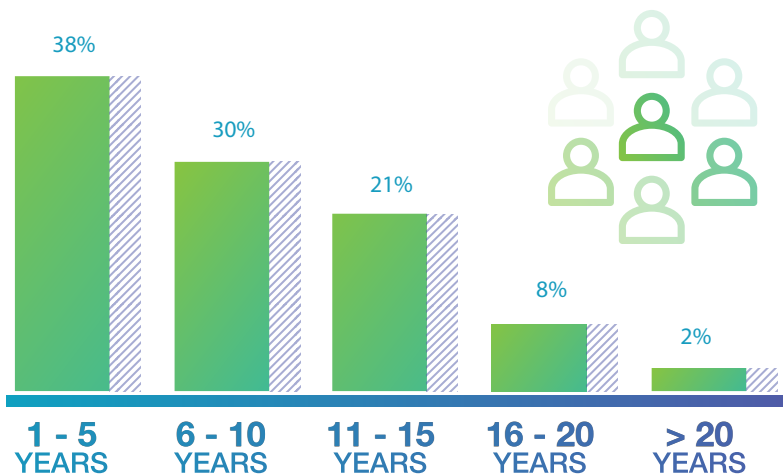
▶ Gartner studies show that **AI technologies** will be in almost every **new software product** by 2020.

The industry forecast

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Professional Experience of Participants

Experience	Percentage
1 - 5 YEARS	38%
6 - 10 YEARS	30%
11 - 15 YEARS	21%
16 - 20 YEARS	8%
> 20 YEARS	2%

Major Organisations where Participants work

Adobe · accenture · CISCO · vodafone · SAP · Deloitte. · BARCLAYS · SOCIETE GENERALE · HSBC

intel · Infosys · EMERSON · BOEING · DELLEMC · Mercedes-Benz · WELLS FARGO · JUNIPEr · CITRIX

Capgemini · SIEMENS · LARSEN & TOUBRO · BOSCH · amazon · HCL · J.P.Morgan · Jio · hp

ABB · Schneider Electric · ERICSSON · TATA · wipro · AMERICAN EXPRESS · KPMG · Fidelity · HEXAWARE

Symantec. · Ford · IBM · DUPONT · Cognizant · AUTODESK · Mahindra COMVIVA · HITACHI Inspire the Next

GE · ORACLE · Honeywell · NOKIA · Gartner · goibibo · Gap Inc. · VISA

verizon · PHILIPS · Whirlpool · McAfee · TEXAS INSTRUMENTS · WalmartLabs · ZOHO · WD Western Digital

nVIDIA. · Mahindra COMVIVA · VOLVO TRUCKS · RBS · Microsoft · BT · HYUNDAI MOBIS · LOWE'S · PayPal

Organisations where participants are employed at the time of joining the programme

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Programme Highlights

11-month Post Graduate certificate programme covering concepts in depth such as Regression, Deep Learning, and Text Mining using Python

The programme can be pursued online, without taking a career break

Two Campus Immersion modules of 2-days each at the Hyderabad Campus of BITS Pilani, during which participants will visit the Campus to interact with their peers and learn together from BITS faculty

Comprehensive and rigourous curriculum covering key concepts and technologies of Artificial Intelligence and Machine Learning

An 8-week Capstone project where you will work towards solving a Data Science related business problem under the mentorship of BITS Pilani faculty members and senior industry practitioners

Extensive digital content including expert lecture videos, and engaging digital learning material

Access to BITS Pilani instructors through online live lectures, a responsive Q&A support and discussion forums

Participants who successfully complete the programme will become members of an elite & global community of BITS Pilani Alumni

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Programme Objectives

1. Enable working professionals to be industry ready in AI&ML space.

2. Produce professionals with strong algorithmic perspective of AI&ML.

3. Provide comprehensive understanding of the data science pipeline.

4. Provide deeper understanding of AI&ML techniques to enhance informed decision making.

5. Provide hands-on to solve real life AI&ML problems.

Learning Outcomes

After completing this program the student will be able to

1. Decide whether AI&ML techniques are applicable for a given business problem and articulate its benefits thereof.

2. Formulate business problems as AI&ML Problem.

3. Collect data and apply pre-processing techniques.

4. Apply Supervised Learning, Unsupervised learning, Deep Learning, Visualization techniques.

5. Identify appropriate techniques to solve the formulated AI & ML problem.

6. Implement and compare the relevant algorithms using Python.

7. Interpret and present the predicted model.

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Programme Structure

The 11-month online Post Graduate Programme in Artificial Intelligence and Machine Learning consists of 6 Courses and a Capstone Project.

Course 1: Regression
6 weeks

Course 2: Feature Engineering
4 weeks

Course 3: Classification
8 weeks

Course 4: Unsupervised Learning
& Association Rule Mining
7 weeks

Course 5: Text Mining
5 weeks

Course 6: Deep Learning and ANN
6 weeks

Course 7: Capstone Project
8 weeks

In addition to the Curriculum above, participants will have the option of taking an optional course on Python at the beginning of the Programme. This will allow participants to revisit essential concepts that will help in all other courses during the programme. Topics covered include Introduction to Python programming and installation, Data Types, Program constructs, Numpy, Pandas, Matplotlib, and Debugging python programs.

Eligibility

Employed professionals holding BE/ B.Tech. or equivalent, and working in relevant fields are eligible to apply. Candidates holding M.Sc. in Mathematics or Statistics, and working in relevant roles are also eligible to apply to this programme. A working knowledge of languages such as Python is recommended.

Applicants without sufficient exposure to Python programming language will have to complete a refresher course in Python as a part of the programme before the start of Course 1.

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Programme Fee
INR 2,25,000 (including GST)
(No cost EMI option available)

Fee Payment Schedule

Block amount (within 7 days of reciept
of provisional Admission Offer Letter)
INR 25,000

Remainder Programme Fee
(within 15 days of reciept
of Final Admission Offer Letter)
INR 2,00,000

Admissions Open. Last Day to Apply is Feb 24, 2020.

No-cost EMI Option

No-cost EMI Option is now available that allows you to pay programme fee in an easy and convenient way.

- Pay fee in easy installments of INR 13,333 p.m. with 0% interest
- Instant online approval in seconds
- No Credit Cards/ CIBIL score required
- Easy & Secure online process using Aadhaar and PAN number
- Anyone with a Salary Account with Netbanking can apply

For details on No-cost EMI option with 0% interest, click here.

Application Instructions

1. Click here to visit the BITS Pilani Online Application Center. Create your login at the Application Center by entering your unique Email id and create a password of your choice. Once your login has been created, you can anytime access the online Application Center using your email id and password.

2. You will receive a Provisional Admission Offer Letter within 2 days of receipt of your Application Form.

3. Upon receiving the Provisional Admission Offer Letter, you will need to submit the following within 7 days using the Online Application Center:
   a. Block amount of: INR 25,000
   b. Scanned copy of Passport size photograph
   c. Scanned copy of self attested Graduation degree certificate and marksheets
   d. Proof of ID (Govt. issued ID such as Driving License, Passport, Aadhar, Voter ID, etc.)
   e. Proof of employment, such as Work Experience Certification from current employer.

4. Within 7 days of receiving the Block amount and other supporting documents, you will receive a Final Admission Offer Letter. You will need to submit the Remainder programme fee (INR 2,00,000) within 15 days of receipt of this letter. For details on No-cost EMI option with 0% interest, click here.

5. Upon receipt of the remaining Remainder fee, you will receive your BITS Student ID, detailed programme schedule and access to the learning platform.

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admission@wilp.bits-pilani.ac.in   +91-40-67874610

Meet the Instructors

Prof. Aruna Malapati

Prof. Aruna Malapati is an Associate Professor in the Department Computer science and Information systems at BITS Pilani Hyderabad Campus since 2010. She received her Bachelor's Degree from Gulbarga University followed by a Master's Degree from BITS Pilani and eventually a Ph.D from NIT, Karnataka. Her research interests are Information Retrieval, Data Mining, Big Data and Machine Learning. Most of her work has been on improving the understanding of Natural Language documents and Music mainly through the application of data mining and Machine Learning. She has published 14 papers in national and international journals and 25 papers in conferences.

In the year 2007 the Govt of Andhra Pradesh and Institution of Engineers recognized her contributions to research and teaching with the "Young Engineer of the Year" award. She has recently received "Women in education award" from Dewang Mehta National Education Awards in April 2017 and the citation of Prof. Indira Parikh 50 Women in Education Leaders at the World Education Congress 2017.

Prof. N L Bhanu Murthy

Prof. N L Bhanu Murthy is working as an Associate Professor in the Department of Computer Science and Information Systems at BITS Pilani-Hyderabad, India. Before joining the Hyderabad Campus, he worked in IT industry for more than ten years in the roles of Enterprise Architect and Program Manager. He completed his Ph.D. from Indian Institute of Technology, Mumbai and M.Tech from Indian Institute of Technology, Delhi. His current research interests are Empirical Software Engineering and Machine Learning.

List of instructors is indicative only

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Meet the Instructors

Prof. Vimal SP

Prof. S.P. Vimal is an Assistant Professor in the Work Integrated Learning Programmes Division of BITS Pilani. His area of expertise is Machine Learning, Compiler Design, Algorithms Design and Computer Vision and has been engaged in research and teaching in these areas for the last 14 years. Vimal completed his Masters in Computer Science and Engineering from Manonmaniam Sundaranar University, Tirunelveli in 2005. He is an active professional member of IEEE and ACM.

Prof. Kamlesh Tiwari

Dr. Kamlesh Tiwari is working as an assistant professor in the department of Computer Science and Information Systems at Birla Institute of Technology and Science Pilani - Pilani Campus. He has earned his Ph.D. degree from the Department of Computer Science and Engineering from Indian Institute of Technology Kanpur (IIT-K). He is a member of IEEE and Signal Processing Society (SPS). He convenes International Workshop on Applied Machine Learning (IWAML) and International Workshop on Applied Deep Learning (IWADL) at regular interval. He heads AI-ML lab and is a co-in charge of Advanced Data Analytics & Parallel Technologies Lab at BITS Pilani. He is also an active member of Multimedia & HCI Laboratory. His research interests lie in Machine Learning, Computer Vision, Multimodal Biometric (Fingerprint, Face, Palmprint, knuckleprint) and Security.

List of instructors is indicative only

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Programme Curriculum:

Course 1

Regression

Regression is a widely used statistical learning method, and this course will enable participants to have a deeper understanding of regression models both from theoretical and implementation perspective.

The course covers concepts such as lasso regression, ridge regression and the interpretability of the predicted models.

This course aims to:
- Provide comprehensive algorithmic perspective of building regression models
- Provide deeper understanding of overfitting and ways to combat overfitting
- Provide competence to select appropriate model and performance measures
- Provide hands-on to solve real life classification problems
- Provide skill to interpret the predicted model

Learning Outcomes

Upon completion of this course, participants will be able to
- Build appropriate regression model for a given real life business problem
- Demonstrate the capability to select suitable degree of the polynomial regression and performance measures
- Suggest appropriate methods to combat overfitting
- Interpret the regression model

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Curriculum: Regression

Topics Covered	
Overview of certificate programme in ML & AI	1. Introduction to six modules of the programme 2. Programme Objectives & Learning outcomes 3. Evaluation of the courses (Quizzes/Assignments/Tests) 4. ML&AI in today's world 5. A real life ML&AI project and value of it to the business
Introduction to Regression	1. Introduction to Supervised Learning 2. Regression vs. Classification 3. Linear and Polynomial Regression 4. Applications and Case Study for the module 5. Overview of Model Building for Linear Regression
Mathematics Foundations	1. First and Second derivatives of multivariate functions 2. Maxima and Minima of univariate and Multivariate Functions 3. Convex Function, Necessary and sufficient condition for convexity of functions 4. Determinant & Inverse of Matrices, Solving Simultaneous Equations
Model Building using Least squares	1. Cost/Loss Function for linear regression 2. Convexity of the Cost/Loss Function 3. Optimizing Cost/Loss Function by Solving Normal Equations 4 Implementation in Python 5. Optimizing Cost/Loss Function by Gradient Descent (I) 6. Optimizing Cost/Loss Function by Gradient Descent (II) 7. Optimizing Cost/Loss Function by Stochastic Gradient Descent and Batch Gradient Descent 8. Implementation in Python (Gradient & Stochastic Gradient Descent Methods)
Model Accuracy & Selection	1. Measuring the Quality of Fit 2. Implementation in Python 3. Bias-Variance Decomposition 4. Training Data, Testing Data and Cross Validation Data 5. Polynomial Regression - Selecting the appropriate degree of the polynomial 6. Implementation in Python
Overfitting	1. Introduction to Overfitting 2. Reasons for overfitting 3. Counters to control overfitting – Ridge Regression 4. Implementation in Python (Ridge) 5. Counters to control overfitting – Lasso Regression 6. Implementation in Python (Lasso) 7. Compare Ridge vs Lasso vs Model without Regularization with a case study
Interpretability of regression models	1. Statistics Foundations – Inferential Statistics and Hypothesis Testing, Significance tests, p-values (1) 2. Statistics Foundations – Inferential Statistics and Hypothesis Testing, Significance tests, p-values (2) 3. Interpretability of regression model through coefficients of the model 4. Interpretability of the regression built for the Case Study 5. Discussion on regression for a real life business scenario

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Course 2

Feature Engineering

Feature Engineering is an important step to develop and improve performance of Machine Learning models. In this course, students will learn different data wrangling techniques that help transforming the raw data to an appropriate form on which learning algorithms can be applied.

This course enables students to identify and implement appropriate feature extraction and pre-processing techniques. The Visualization techniques will also be taught in this course.

This course aims to help participants:
- Apply data wrangling for a given business problem
- Identify and implement appropriate feature extraction and selection techniques.
- Apply data preprocessing techniques
- Implement dimension reduction using PCA
- Identify and implement appropriate visualization techniques.

Learning Outcomes
Upon completion of the course, participants will be able to:
- Understand the importance of dimension reduction and apply appropriate techniques given a real world application.
- Compare the use of different similarity measures and Identify the appropriate similarity measure to be used between 2 or more items, concepts, etc
- Find and select appropriate visualization technique that answers a particular research question.


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Curriculum: Feature Engineering

Topics Covered	
Overview of Feature Engineering	1. Introduction to Feature Engineering 2. Types of data and its sources 3. Data quality (Missing values, Noisy data) 4. Implementing a Scrapper using Python
Data Preprocessing	1. Aggregation and Sampling 2. Feature Creation 3. Discretization and Binarization 4. Data Transformation 5. Feature Subset Selection 6.1 Feature selection using Filter Methods 6.2 Feature selection using wrapper methods 7. Implementing Feature selection using Python 8. Similarities between attributes -1 9. Similarities between attributes -2
Dimensionality Reduction	1. Statistics foundations (Variance, Covariance) 2. Introduction to Dimension reduction 3. Principal Component Analysis (PCA) using Minimum Variance formulation-1 4. Principal Component Analysis (PCA) using Minimum Variance formulation-2 5. Principal Component Analysis (PCA) using Minimum Variance formulation-3 6. Implementing PCA using Python 7. Industry talk on feature engineering for a problem domain
Visualization (Industry Expert)	1. Summary Statistics 2. Histograms 3. Bar Charts / Pie charts 4. Box / scatter plots 5. Contour plots 6. Heat maps 7. Parallel Coordinates 8. TSNE 9. Industry talk on Visualization

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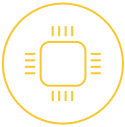
Course 3

Classification

The course on Classification lays down a strong foundation on the algorithmic perspective of popular classification algorithms - k-NN, Naïve Bayes, Decision Tree, Logistic Regression and SVM. The implementation details of these models along with tuning of parameters will be illustrated. The course also covers concepts such as ensemble methods like bagging, boosting, Random Forest, and interpretability of the predicted models.

The course aims to:
- Provide deeper understanding of three types of techniques to solve classification problems
- Provide comprehensive algorithmic perspective of popular classification algorithms
- Provide hands-on to solve real life classification problems
- Provide the skill to interpret the predicted model
- Provide the competence to build ensemble classifiers using well known techniques

Learning Outcomes

Upon completion of the course, participants will be able to:
- Build appropriate classifier for a given real life business problem
- Demonstrate the capability to understand classification algorithms deeply and fine tuning the parameters therein to enhance performance of the classifier
- Build ensemble classifier using well known techniques
- Interpret the regression model

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Curriculum: Classification

Topics Covered	
Overview of the Classification Module	1. Introduction to Classification 2. Types of classification algorithms - Discriminant Functions, Probabilistic Generative models and Probabilistic Discriminative models, Tree based models 3. Classification Algorithms covered in the course and type of these algorithms 4. Applications of classification and case study
Nearest-neighbour Methods	1. kNN Classifier 2. Measures of prediction accuracies of classifiers – precision, recall, AUC of ROC etc. 3. Finding optimal k 4. Python Implementation of kNN
Naïve Bayes Classifier	1. Probability Foundations – Discrete & Continuous Random Variables, Conditional Independence, Bayes Theorem (1) 2. Probability Foundations – Discrete & Continuous Random Variables, Conditional Independence, Bayes Theorem (2) 3. Naïve Bayes Classifier – Derivation 4. Python implementation of Naïve Bayes Classifier 5. Naïve Bayes Classifier is a generative model 6. Advantages of Naïve Bayes Classifier and when to use Naïve Bayes Classifier? 7. Interpretability of Naïve Bayes Classifier
Logistic Regression	1. Significance of Sigmoid function and finding its derivative 2. Statistics Foundations – Maximum likelihood estimation 3. Cross entropy error function for logistic regression and its optimal solution 4. Logistic Regression is probabilistic discriminative model 5. Implementation of logistic Regression using Python 6. Decision boundary of logistic regression 7. Overfitting of logistic regression and counter measures 8. Interpretability of logistic regression
Decision Tree	1. Decision Tree Representation 2. Entropy and Information Gain for an attribute 3. Search in Hypothesis space, ID3 Algorithm for decision tree learning 4. Implementation of Decision Tree using Python 5. Prefer short hypothesis to longer ones, Occam's razor 6. Overfitting in Decision Tree 7. Reduced Error Pruning and Rule post pruning 8. Alternative measures for selecting attributes 9. Interpretability of Decision Tree

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Curriculum: Classification

Topics Covered	
Optimization Foundations for Support Vector Machines	1. Constrained and Unconstrained Optimization 2. Primal and Dual of an optimization problem 3. Quadratic Programming 4. KKT conditions 5. Lagrange Multiplier
Support Vector Machines	1. Understanding the spirit and significance of maximum margin classifier 2. Posing an optimization problem for SVM in non-overlapping class scenario 3. Converting the constrained optimization problem into unconstrained using Legrange multipliers 4. Dual of the optimization problem 5. Appreciation of sparse kernel machine and support vectors in the solution of the optimization problem 6. Implementation of SVM in python
Support Vector Machines in overlapping class distributions & Kernels	1. Issues of overlapping class distribution for SVM 2. Posing an optimization problem for SVM in overlapping class scenario 3. Solving the optimization problem using Legrange multipliers, dual representations 4. Kernel Trick and Mercer's theorem 5. Techniques for constructing Kernels and advantages of Kernels in SVM 6. Implementation of SVM using different kernels
Ensemble Methods	1. Rational for Ensemble Method 2. Methods for constructing an Ensemble Classifier 3. Bagging, Boosting, AdaBoost 4. Random Forest 5. eXtreme Gradient Boosting (XGBoost) 6. Python Implementation of Random Forest and XGBoost 7. Class Imbalance Problem & approaches to solve it

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Course 4

Unsupervised Learning & Association Rule Mining

The course on Unsupervised Learning & Association Rule Mining focuses in finding natural groups or clusters that are present in the data. The course will cover lustering algorithms like K-means, Hierarchical & DBSCAN algorithms, Hidden Markov Models for time series prediction, and market basket analysis to generate the interesting rules from a transactional database.

The course aims to:
- To introduce unsupervised learning, various unsupervised learning algorithms
- To introduce Association rule learning and apriori algorithms
- To introduce time series data and use HMM to solve various tasks involving Time series data

Learning Outcomes

Upon completion of the course, participants will be able to:
- Understand various algorithms for clustering, association rule mining and the role of HMM in time series prediction tasks
- Analyse the problem and provide learning solutions using the algorithms covered in this course
- Apply the learning algorithms suitably to solve various tasks including anomaly detection, parameter estimation, segmentation etc.
- Analyse the given problem, decide the suitability of association rule learning technique to solve this and provide a solution
- Apply the HMM suitably to solve problems involving time series data

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Curriculum: Unsupervised Learning & Association Rule Mining

Topics Covered

Introduction to Unsupervised Learning, Clustering	1. Unsupervised Learning - Introduction - Applications- Clustering as a unsupervised learning task - Defining clustering 2. Introducing Various ways to solve clustering problem (similarity based, density based, hierarchical, graph theoretic based) - Notion of quality of clustering 3. Overview of clustering algorithms

Case Study	1. Introducing the clustering case study (to be identified) to be used throughout the course for assignments -
	    i. overview of the data set to be used -
	    ii. Exploring this data using Python

K-Means Algorithm	1. K-Means Algorithm 2. Discussion on Various Initializations, Standardizing Attributes (for eg- z-score) & Convergence 3. Demonstration in Python 4. Applications of using K-means with Images, videos, documents
K-Means - Variations	1. Online stochastic version of k-means (with sequential update) - Discussions on quality of clustering / convergence - Applications 2. Mini-Batch K-Means - Discussions on quality of clustering / convergence - Applications
Detecting Outliers	1. Outliers and Clustering - Overview. 2. Using K-means to detect outliers 3. Demonstration in Python
Math Fundamentals for EM Algorithm	1. Jensen's Inequality 2. KL Divergence

EM Algorithm	1. Mixtures of Gaussians (MoG) - Applications, modelled as MoG
	2. Using Maximum Likelihood to estimate mixture densities - Issues
	3. EM Algorithm for Gaussian mixtures
	    i. Derivation
	    ii. Illustration of a problem using a mixture of two Gaussians, and Python
	    iii. General Form of EM Algorithm and Applications
	4. Relationship to K-Means Algorithm

Clustering for Customer Segmentation	

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Curriculum: Unsupervised Learning & Association Rule Mining

Topics Covered	

Hierarchical Clustering	1. Introduction to hierarchical clustering
	2. Agglomerative Clustering Vs Divisive Clustering
	3. Distance Measures (Minimum distance, Maximum Distance, Mean Distance, Average Distance)
	4. Algorithms
	      i. Single linkage, Complete Linkage algorithm
	      ii. Demonstration in python
	      iii. Discussion on Termination, efficiency, applications

Density Based Clustering **Clustering for Anomaly Detection**	1. Density based approach to clustering - Introduction 2. DBSCAN - Density, Density-reachability, Density-connectivity 3. DBSCAN Algorithm 4. Performance & scalability 5. Demonstration using Python
Assessing Quality of Clustering **Significance of Clustering - Interpreting/ summarizing Clusters by businesses**	1. Cluster Validity Evaluation (measuring compactness, separation, cluster overlap, etc) 2. Stability of Results from clustering algorithms 3. Determining number of clusters
Association Rule Mining **Apriori Algorithm**	1. Market Basket Analysis - Use cases 2. Terminologies / Measures - association rules, support, confidence ,k-itemset, Frequent itemsets, closed item sets 3. Discussion on computational complexity in generating the itemsets 1. Algorithm 2. Generating Association Rules from frequent itemsets 3. Efficiency Issues and few ways to address it. 4. Evaluating interestingness of patterns 5. Demonstration of Apriori algorithm using python for a practical use case

Time series Prediction and Markov Process
 	
Hidden Markov Model
	1. Introduction
	      i. Introduction to time series data
	      ii. Time Series prediction applications (eg predicting stock prices, fraud detection, applications in text and speech processing)
	2. (discrete) Markov Processes - Overview and Terminologies
	
	i. Introduction
	ii. Evaluation Problem - Given a model, evaluate the probability of observing the sequence - (forward-backward Procedure)
	iii. Finding most likely state sequence explaining time series data - Viterbi Algorithm
	iv. Learning Model parameters - An application of EM Algorithm
	
	2. Case Study: Introduce a problem from an application domain- solution using HMM - Python Implementation / Demonstration

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Course 5

Text Mining

Text mining is the process of deriving high-quality information from text and this is the fifth course of the program. This course aims to equip students with adequate knowledge in extracting the relevant text data and skills to identify patterns therein. This course covers topics like converting documents to vectors, Parts of Speech Tagging, Topic modelling, sentiment analysis and recommender systems.

This course is designed to help participants:
- Convert documents into vectors using TF-IDF and compute similarities
- Implement topics modelling using LDA
- Apply sentiment analysis
- Implement recommender systems

Learning Outcomes

Upon completion of the course, participants will have:
- Students should have gained knowledge of basic pipeline of Information retrieval and vectorising the documents using TD-IDF and its implementation.
- Students should have gained a mathematical foundation on modelling Parts of speech (POS) tagging using Hidden Markov Model and hands on experience of implementing POS tagging.
- Students should have gained a mathematical foundation on modelling Latent Dirichlet Analysis (LDA) for topic modelling and hands on experience of implementing it.
- Students should have gained knowledge on sentiment analysis and its applications.
- Students should have gained a mathematical foundation of Recommender Systems and hands on experience of implementing it.

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Curriculum: Text Mining

Topics Covered	
Document vectorization and Parts of Speech Tagging	1. Introduction to Text Mining 2. Binary term incidence matrix 3. Information Retrieval Pipeline 4. Inverted Index Construction 5. Merge Algorithm and Query Optimization 6. Tolerant Retrieval using Normalization, Query expansion, Stemming, Lemmatization, Wild card query using K-Gram index 7. Ranked Retrieval using TF-IDF and Cosine score 1. Introduction to Part of speech tagging 2. Part of speech tagging using HMM-1 3. Implementing POS Tagging in Python
Topic modelling using LDA	1. Mathematical foundations for LDA : Multinomial and Dirichlet distributions-1 2. Mathematical foundations for LDA : Multinomial and Dirichlet distributions-2 3. Intuition behind LDA 4. LDA Generative model 5. Probabilistic Graphical Models 6. Latent Dirichlet Allocation 7. Implementing LDA in Python
Introduction to Sentiment Analysis	1. Sentiment Analysis 2. Subjectivity Analysis 3. Topic Extraction 4. Product Reviews 5. Opinion Retrieval and Spam 6. Opinion Summarization 7. Implementing Sentiment Analysis in Python

Recommender Systems	1. Introduction to Recommender Systems
	2. Collaborative filtering
	   2.1 User based Collaborative filtering
	   2.2 Item based Collaborative filtering
	   2.3 Matrix factorization using Singular Value Decomposition
	   2.4 Latent Factor Models
	3. Metrics used for evaluating Recommender Systems
	4. Implementing Recommender System in Python
	5. Industry talk on application of Recommender Systems

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Course 6

Deep Learning and ANN

Deep learning is an evolving subfield of Machine Learning and this course starts with traditional Neural Networks followed by sequential networks, Convolution Networks, Autoencoders and Generative deep learning models. The implementation details of these deep learning models along with tuning of the parameters will be illustrated in this course.

This course is designed to help participants:

- Learn ML approaches that are inspired by human brain
- Design shallow and deep network using non-linear activation functions
- Understand sequence aware neural networks for text/voice/video etc.
- Learn Convolution Neural Networks to solve typical computer vision problems
- Learn how data compression could be achieved using a network of neurons

Learning Outcomes

Upon completion of the course, participants will be able to:

- Design a multilayer ANN for an appropriate learning problem
- Design multilayer neural network architecture for text/voice/video or any sequence data
- Appreciate the concept of end-to-end learning and feature abstraction
- Apply convolution and highlight useful parts in a scene for computer vision applications
- Apply generative approach to solve ML problems

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Curriculum: Deep Learning and ANN

Topics Covered	
Artificial Neural Network	1. Introduction and Background 2. Discrimination power of single neuron 3. Training a single perceptron (delta rule) 4. Multilayer Neural Networks 5. Activation functions and Loss functions 6. Backpropogation -1 7. Backpropogation -2
Sequence Modeling in Neural Network	1. Architecture of RNN 2. Unfolding of RNN 3. Training RNN 4. LSTM (1) 5. LSTM (2) and its applications
Deep Learning	1. Introduction to end to end learning 2. Abstractions of features using deep layers 3. Hyper parameter tuning 4. Regularization for Deep Learning 5. Dropout
Convolution Networks with Deep Learning	1. CNN 2. Pooling 3. Variants of pooling functions 4. CNN with Fully connected Networks 5. RCNN 6. Faster RCNN
Autoencoders with Deep Learning	1. Undercomplete Autoencoders (1) 2. Regularized Autoencoders (2) 3. Variational autoencoders 4. Manifold learning with Autoencoders 5. Applications of Autoencoders
Generative deep learning models	1. Boltzmann Machine 2. Restricted Boltzmann Machine 3. Deep Belief Machines 4. GAN 5. Applications of GAN

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Course 7

Capstone
Project

During the 8-week Capstone Project, participants will work in teams to design and solve a real-world business problem encompassing data science pipeline using AI&ML techniques. Participants will be required to identify applicable AI and ML solutions, and apply these solutions to arrive at outcomes. Through each phase of the project, participants will be mentored by BITS Pilani faculty members and senior Industry practitioners using a rigourous and structured framework, and will receive regular feedback on their progress.

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FAQs

1. Who is this programme designed for?

The programme can be pursued by employed professionals who hold B.E or B.Tech., and work in Technology related roles. If a professional has the required qualifications and a desire to accelerate his or her career in the highly rewarding domain of AI & MI, this is the ideal programme.

2. What certification do I receive at the end of the programme?

Upon successful completion of the programme, participants will receive a Post Graduate Certificate in Artificial Intelligence and Machine Learning from BITS Pilani in addition to an Official Transcript and Programme GPA.

3. Will I become an alumni of BITS Pilani upon completion of this programme?

Yes. The qualification will provide you the prestigious BITS Pilani Alumni status, through which you will become member of an elite & global community of BITS Pilani Alumni.

4. How is this programme different from others?

a. A unique and specialised programme in Artificial Intelligence and Machine Learning that helps participants gain deep conceptual understanding and the skills that are highly valued by the industry

b. A rich & flexible learning methodology allows one to pursue the programme without any career break.

c. Engaging digital learning experience that involves expert lecture videos, assignments, online live classes and discussion forums. In addition you will also be able to clear your doubts through periodic live sessions with faculty and active online discussion forums.

d. The programme includes a 8-week rigorous project under the guidance of BITS Pilani faculty members and senior industry practitioners

e. The programme includes two Campus Immersion modules of 2-days each at BITS Pilani. All participants will need to travel to the BITS Pilani campus over a 2-day weekend and participate in a special faculty interaction and engaging learning activities.

f. Successful completion of the programme will provide you the prestigious BITS Pilani Alumni status, through which you will become member of an elite & global community of BITS Pilani Alumni.

5. What is the weekly time commitment expected?

Participants will be expected to devote 8-10 hours each week to fully benefit from programme. You will be able to engage with lecture videos, complete periodic assignments, and interact with the cohort through discussions forums for a rich academic experience.

6. How will my doubts/questions be resolved in an online programme?

Programme participants will be able to engage with instructors to clear their academic doubts:

a. Periodic live sessions with instructors will help you to clear your doubts and seek answers.

b. BITS Pilani faculty members and Teaching Assistants will be available through discussion forums and email.

c. Discussion forums will help you interact with other participants to seek an offer support.

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7. What is the Capstone Project?

During the 8-week Capstone Project, participants will work in teams to design and solve a real-world business problem encompassing data science pipeline using AI&ML techniques. Participants will be required to identify applicable AI and ML solutions, and apply these solutions to arrive at outcomes. Through each phase of the project, participants will be mentored by BITS Pilani faculty members and senior Industry practitioners using a rigourous and structured framework, and will receive regular feedback on their progress.
Your project work is the showcase to the industry of your expertise in the domain of AI & ML.

8. Is there any minimum qualification required to apply for this programme?

Employed professionals holding BE/ B.Tech. or equivalent, working in IT related roles are eligible to apply to this programme. A working knowledge of languages such as Python is recommended.

9. Will I get a job after this programme?

With the huge amount of available data, industries are now inspired to move towards data driven decision making and hence there is a huge demand for experts in the area of Machine Learning and Artificial Intelligence. The demand for these skills has been increased by their widespread applications in industries such as Retail, Banking and Manufacturing. Therefore it is no surprise that the skills in these areas are the most sought after.

BITS Pilani has studied the skills required for popular Data Science related roles such as Data Scientist, Machine Learning Engineer, AI Product Manager, Data Engineer, Applied ML Scientist, and many other rewarding opportunities.

The curriculum has been mapped to these roles and provides you with the knowledge, skills and expertise required to take up these in any AI & ML related role. We believe that armed with these skills an engineer will be sought after by the industry. Please note that BITS Pilani does not offer placement assistance as a part of this programme.

10. What is the Refund/ Deferral guidelines in case I am unable to continue, or need to take a break between the programme?

Refund: Participants may cancel their admission upto the first 14 days from the start of the cohort i.e. Programme Start date (launch of Course 1). He/ She will be eligible to get a full refund of his programme fee paid, minus the bank processing charges and applicable taxes (the taxes won't be refunded). Refund will be processed within a maximum of 45 working days. The participant will be required to fill in a refund form that will be made available by the Admission Cell.

Deferral: If a participant is facing severe issues in dedicating time to the course, we provide the opportunity for the participant defer to another batch. Participants can request for deferral ONLY ONCE and to the next immediate scheduled cohort of the same programme.
Participants will be required to pay a deferral fees of 10% of programme fees (including GST). The deferral request will be approved once the deferral fees is paid. Till this is completed, the participant will be assumed to be continuing in the same cohort. Participant will start learning on the new cohort from the point of leaving the deferred cohort. If, however, the deferral request is raised before the issue of BITS Student ID, the 10% deferral fees will not be charged and participant will be deferred to the next scheduled cohort. However, in case there is any fee differential between his current cohort and the cohort he/she has deferred to, the participant will have to pay the differential amount.

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