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Fusemachines AI Fellowship-2023

A year-long program to train, educate, and help create advanced AI career opportunities

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About the program:

The Fusemachines AI Fellowship is a dynamic program created with a keen focus on training and upskilling engineering students, graduates and postgraduates to make them ideally suited for an AI career. First launched in 2017, each routinely updated program is episodically remodeled to offer innovative and up-to-date courses. The 2023 program offers Fusemachines' proprietary Microdegree™ programs, with courses holding direct relevance to the AI field. Fellows will receive a Full Scholarship and a possible job placement opportunity after the successful completion of the program.

Courses:

Microdegree™ in AI

- Machine Learning (3 Months)
- Deep Learning (3 Months)

Microdegree Specialization

- Computer Vision (3 Months)
- Natural Language Processing (3 Months)

Course Prerequisites:

Students are recommended to take the foundations course in programming and have got introduced to the basic idea of machine learning before joining this course. It is highly recommended that students have completed the following course or topics before beginning with this course

Computer Science for AI

- Python Programming and Common Python Libraries
- Data Structures and Algorithms
- REST API

Mathematics for AI

- Linear Algebra
- Multivariate Calculus
- Probability and Statistics

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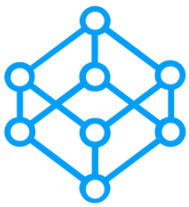

Machine Learning

Course Objective:

After the completion of this course, students will be able to:

- Explore the key concepts of machine learning workflow, supervised, unsupervised learning algorithms and benefits/limitations of machine learning.
- Summarize the intuition of parameter estimation techniques, ordinary least squares, gradient descent and validation.
- Explain the idea behind decision trees, decision tree inducers and overfitting in decision trees.
- Apply KNN, SVM, distance-based partitioning algorithms and hierarchical clustering algorithms for cluster analysis.
- Relate simple time series models with mixed and advanced models.

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Syllabus

Module 1 Introduction to Machine Learning

Introduction to Machine Learning, Data cleaning, Data Quality inspection and cleaning, Deduplication and missing value, Outlier handling and ML Workflow

Module 2 Linear Regression

Introduction, Least Squares- Simple Regression, Multiple Regression and Geometric intuition, Gradient descent- Gradient descent method, Gradient descent for linear regression and Importance of Standardization, Regression Validation and Regularization, Ridge regression, Lasso regression and Elastic Net regression

Module 3 Decision Trees

Overfitting and Underfitting , Early Stopping, Pruning and importance, Impurity metrics, Decision tree inducers,Decision tree implementation,Multivariate decision tree and Metrics and scoring

Module 4 Ensemble methods

Error Decomposition, Ensemble, Bagging, Random Forest, Boosting, Adaboost, Gradient Boosting and XGBoost

Module 5 Probabilistic Models

Introduction to Probabilistic Models, Frequentist vs Bayesian Approach to Probabilistic Models, Introduction to probability distribution - Discrete probability distribution and Continuous probability distribution, Maximum Likelihood Estimation(MLE) for Multivariable Gaussian, Linear Regression and Logistic Regression, Maximum a Posteriori (MAP) and Bayesian Approach for Parameter estimation

Module 6 Clustering

Partition based clustering- KMeans Formal algorithm (Loss function non-convex) and KMeans variants, Hierarchical Clustering - Agglomerative clustering algorithm and BIRCH (Micro Phase: Macro Phase), Density Based Clustering- DBSCAN and OPTICS, Cluster Validation

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Module 7 Dimensionality Reduction

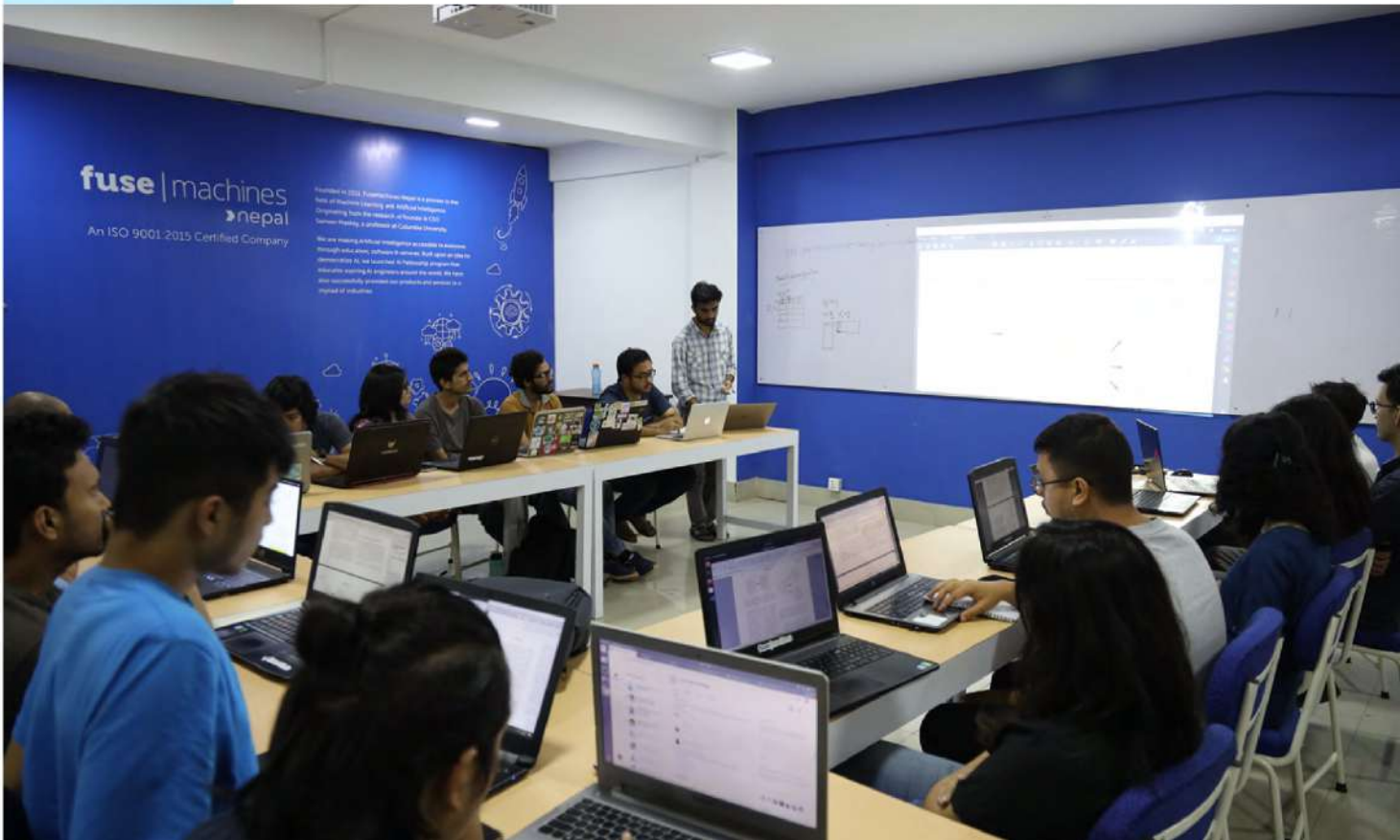
Dimensionality reduction and SVD- Singular Value Decomposition (SVD) as a low-rank decomposition for any matrices and curse of dimensionality and necessity for dimensionality reduction, Principal Component Analysis(PCA)- objective and the purpose of PCA, working of PCA and the role of covariance matrix, eigenvalues and eigenvectors in it and application and limitation behind.

Module 8 Time Series Analysis

Introduction to Time Series- Understand the concept of time-series and its difference from conventional machine learning problems, Naive TSA Models, Simple models- Autoregressive(AR) Models and Moving Average(MA) Models, Mixed models- ARMA model, ARIMA model, SARIMA model and ARIMAX and SARIMAX model, Exponential smoothing

Module 9 Reinforcement Learning

Introduction to RL, Fundamental of Reinforcement Learning- K-arm bandits, Exploration vs Exploitation tradeoff, Markov Processes and Markov Reward Processes, Markov Decision Processes, Dynamic Programming, Sample based learning methods- Monte Carlo Methods, Temporal Difference.



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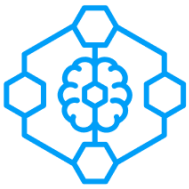

Deep Learning

Course Objective:

After the completion of this course, students will be able to:

- Understand different types of Deep Learning Architectures, such as Artificial neural networks, Convolutional Networks, Recurrent Networks and Autoencoders.
- Master the process of creating a Deep Learning pipeline
- Build, train, evaluate and make predictions from deep learning models, validating your models and including regularization, implementing callbacks, and saving and loading models.

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Module 1 Neural Networks

Introduction to Module, Computational Graphs and Backpropagation, Tensorflow ANN, Activation Function- sigmoid, tanh and also variations of ReLU, Weight Initialisation and types, Xavier Initialization and He and LeCun initialization, Optimization Methods- Stochastic Gradient Descent with momentum, AdaGrad, RMSprop, Adam Optimizer, optimization methods, Normalisation- Standardisation and min-max Normalization, Batch Normalization and Layer Normalization, Regularization- L1 and L2 Regularization, Dropout, and Data Augmentation, Early Stopping, Weight Decay, Hyperparameter Tuning.

Module 2 Convolutional Neural Networks

Building Blocks- Forward Propagation in CNN, Backpropagation in Convolutional Layer and Forward and back propagation in Pooling layers, Seminal Architecture- BFF, ResNet and Inception Net

Module 3 Recurrent Neural Networks

Introduction to RNN-Vanilla RNNs and Backpropagation through time (BPTT) in RNN, Computation for LSTM and Computation for GRU, CNN + RNN and CNN-LSTM

Module 4 Attention and Neural Computation

Neural Attention-Encoder decoder architectures, Attention and its types, Neural Computation- Neural Computers, Neural Turing Machines and Differentiable Neural Computers.

Module 5 Deep Unsupervised Learning

Taxonomy, Boltzmann Machines, Variational- AutoEncoders, Representation Learning, Variational AutoEncoders and Reparameterization Trick, Generative Adversarial Networks (GANs)- Challenges, Wassertein GAN, Deep Convolutional GAN and Conditional GAN

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Module 6 Deep Reinforcement Learning

Continuous Problems- Introduction to Function approximation and Function Approximation, Value based Problems - Deep Q-Network and DQN (Programming material), Policy based- Policy Optimization, Policy Gradient Theorem and Algorithm, Combining Policy & Value based Learning- Actor-Critic and Deep deterministic policy Gradient (DDPG)

Module 7 Applied Deep Learning

Production Techniques- Serving API endpoints, Serving and Data Pipelines and Post Production, Federated Learning, Edge Computing- On Device Inference and Edge Computing, Model Quantization, Tensorflow Lite and Tensorflow JS, Explainable AI

Module 8 Current Research[In future]

Graph Neural Network, Application of GNN, Meta Learning, Few shot and Zero shot learning, Bayesian optimization and Architecture search

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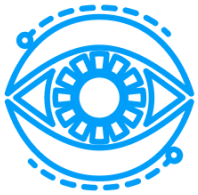

Computer Vision

Course Objective:

After the completion of this course, students will be able to:

- Explore the field of computer vision from its very basics, starting with image formation and its relation to human vision.
- Relate to the challenges of Computer Vision and the evolution of algorithms that deal with these challenges.
- Identify the existing and possible application areas to apply a Computer Vision approach to solutions.
- Extend basic programming knowledge while getting to work with handy open source CV tools for image manipulation tasks.

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Syllabus

Module 1 Introduction to Course

Introduction to Computer Vision and its applications, Image Manipulation Python Tools- OpenCV, Pillow tool, scikit-image tools, Numpy tools, TensorFlow image tools.

Module 2 Image Formation and Representation

Imaging- Lambertian model for image formation, Camera and Lens, Image as a function, Image Representation- Image as a matrix, Image as a 3D tensor, Color Spaces, Imaging Geometry,

Module 3 Image Processing

Point Operators-Simple Point Operators, Histogram Equalization, Binary Operators, Masks, Image Thresholding, Filters, Cross-Correlation and Convolution, Application of Filters, Denoising- Salt and Pepper noise, Gaussian Smoothing and Median Filtering, Sharpening, Out of focus blur (Gaussian Blur), Motion blur (box filter), Image Upscaling and Downscaling, Morphological Processing- Erosion and Dilation, Closing and Opening

Module 4 Feature Detection and Matching

Edge DetectionIntroduction to Edge Detection- 1st order and 2 order edge detection techniques, Canny Edge Detection, RANdom SAmple Consensus (RANSAC), Feature Detection and Matching- Local Invariant Features and Keypoint Localization

Module 5 Segmentation

Introduction and types of segmentation, Split and Merge- Watershed, Mode finding Segmentation, K-means Clustering, Mean Shift Clustering

Module 6 Object Recognition

Introduction to Recognition task, Classification problem in Image, Localization, Template Matching, Detection problem, Sliding Window and Pyramids

Module 7 Video Processing

Introduction to Video Processing, Video Formation, Video manipulation with OpenCV, Tracking Problem - Color Based Tracking, MeanShift Tracking, Action Recognition and Gesture Recognition

Module 8 Deep Learning in Computer Vision

Introduction to CNN, Building Blocks of CNN, Classification- LeNet and Few architectures for classification, Transfer Learning, Localization- CNN based Localization, Detection- CNN Based Detectors and Advanced Object Detectors, Segmentation- Segmentation using FCN, Unsupervised Methods- Auto Encoders

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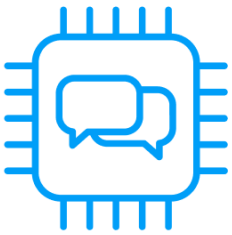

Natural Language Processing

Course Objective:

After the completion of this course, students will be able to:

- Identify the needs, difficulties and domain fields of NLP to build an intuition on the possibilities of real world applications.
- Create basic NLP pipelines using common tools and operations to solve NLP tasks.
- Summarize the architectures of neural language models, continuous bag of words model and skip gram model to train word embeddings.
- Define different linguistic terminologies (morphology, tagging, syntax, parsing, semantics, pragmatics and discourse), morphological classes and derivation phenomenons to understand the complexities of language and its association with knowledge.

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Syllabus

Module 1 Introduction to Natural Language Processing

Introduction to NLP, Application of NLP, Introduction to NLP Tools, loading corpus and lexicon other than one loaded in the reading material.

Module 2 Language and Knowledge

Introduction to Language and knowledge, Morphology, Tagging, Syntax and Parsing, Context Free Grammar, Parsing, Semantics, Pragmatics and Discourse, Lexical Semantics and WordNet, Word Similarity and Vector Semantics and Pragmatics and Discourse

Module 3 Machine Learning for NLP

Basic NLP Pipeline, Raw Text Processing- Loading Data from from different sources, Basic Python string processing, Regular Expression and Common UNIX tools basics, Text Processing- Text Cleaning and Tokenization, Normalization and Stopwords Removal, Vectorization Machine Learning, Applying Machine Learning

Module 4 Language Models

Markov Models- Introduction to Markov Assumption, N-Gram Language Model, Evaluation of Language Models, Generalization and Zeros, Smoothing and Backoff, Word Embedding-Introduction to Word Embeddings- Semantic Interpretations and Properties, Neural Language Models, Word2Vec and Glove Embeddings

Module 5 Deep Learning for NLP

Sequence Models- RNNs for NLP, CNN for NLP and Encoder-Decoder, Attention, Contextual Embedding and Pretraining