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**ILLINOIS TECH**

**Post Graduate Program in**

**Generative AI and ML**

CURRICULUM

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- » M3 - Language Models and Transformer-based Generative Models
- » M4 - Working with ChatGPT
- » M5 - Prompting Techniques for Generative Models
- » M6 - Generative AI with LLMs
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- » M8 - Interacting with Data using Retrieval-Augmented Generation

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- » M10 - LangChain and LlamaIndex for LLM Application Development
- » M11 - Fine Tuning and Evaluating Generative Models
- » M12 - Generative AI on Cloud
- » M13 - Generative AI with Python
- » M14 - Industry Case Studies and Project
- » M15 - Machine Learning with Generative AI (Self-paced)
- » M16 - Generative AI Tools (Self-paced)

# Python Programming for AI and ML

## M1 - Introduction to Python

- Need of Programming
- Advantages of programming
- Demand for Python
- Application of Python in Different Domains
- Fundamentals of Python
- Using the Print Statement
- Standard Data Types
- Python Operators
- Control Structures: Conditional Statements
- Control Structures: Loops
- Structural Pattern Matching

## M2 - Sequences and File Operations

- Reading Keyboard Input in Python
- File Input/Output Operations in Python
- File Objects in Python
- Types of Sequences and their Operations in Python:

- Lists
- Tuples
- Strings
- Sets
- Dictionaries
- Bytes
- ByteArray
- Range

## **M3 - Functions and Object-oriented Programming**

- Function and Its Applications
- Function Arguments
- Variable Scope
- Lambda Functions
- Built-in Functions
- Documentation Strings
- Procedure-Oriented vs. Object-Oriented Programming
- Class and Its Attributes
- Constructors and Destructors
- Generator Functions in Python
- Object-Oriented Programming Concepts

## **M4 - Working with Modules and Handling Exceptions**

- Standard Libraries

- import Statement
- dir() Function
- reload() Function
- Types of Modules
- Important modules in Python
- sys Module
- os Module
- math Module
- datetime Module
- random Module
- JSON Module
- Packages
- Regular Expressions
- Exception Handling
- User Defined Exceptions

## **M5 - Array Manipulation using NumPy**

- Introduction to NumPy
- NumPy Array
- Basic Operations
- Arithmetic Operators
- Matrix Product
- Functions



- Universal Functions
- Aggregate Functions
- Logic Functions
- Indexing
- Fancy Indexing
- Slicing
- Iterating in a NumPy Array
- Array Manipulation
- File Handling Using NumPy

## **M6 - Data Manipulation using Pandas**

- Introduction to pandas
- Functionality of pandas
- Significance of pandas Library
- Data Structures in pandas
- Series and DataFrame
- Importing and Exporting Data
- Merging, Join, and Concatenation of Data Objects
- Cleaning Data
- Grouping Data

## **M7 - Data Visualization using Matplotlib and Seaborn**

- Need for Data Visualization
- The Matplotlib Library

- Types of Plots and Charts
- Customizing Visualizations
- The Seaborn Library
- Types of Plots
- RelPlot
- Scatter Plot
- Line Plot
- Bar Plot
- Count Plot
- Box Plot
- Heatmap
- Cluster maps

## **M8 - GUI Programming**

- GUI Programming
- Widgets
- Introduction to ipywidgets
- Widgets in ipywidgets
- Numeric Widget
- Boolean Widget
- Selection Widget
- String Widget
- Button

- Image
- Date picker
- Container
- Introduction to Tkinter
- Widgets in Tkinter

## **M9 - Developing Web Maps and Representing Information Using Plots (Self-paced)**

- Introduction to Web Maps
- Flow Chart to Create Web Map
- Installing folium and pandas Library
- Applications of Web Map
- Titanic Dataset Analysis

## **M10 - Web Scrapping and Computer Vision using OpenCV (Self-paced)**

- Web Scrapping
- Beautiful Soup Library
- Requests Library
- Introduction to Scrapy
- Scrapy Spider
- Plotting Using Bokeh
- Image Editing Using OpenCV
- Face Detection Using OpenCV
- Image

## M11 - Database Integration with Python (Self-paced)

- Fundamentals of Database
- Need for Database
- Structured Query Language (SQL)
- SQL Properties
- Introduction to Python MySQL
- Connecting Python with MySQL
- Creating a Database
- Creating Tables
- Inserting into a table
- NoSQL Database
- Features of NoSQL
- Advantages of NoSQL
- Types of NoSQL Databases
- Introduction to MongoDB
- Features and Advantages of MongoDB
- MongoDB Terminologies
- CRUD Operations

# Statistical Methods for Predictive Analysis

## M1 - Probability and Statistics

- Why Use Probability?
- What is Probability?
- Rules of probability
- Types of Probability
- Marginal Probability
- Joint Probability
- Conditional Probability
- Random Variables
- Probability Distribution Functions
- Types of Probability Distribution Functions
- Introduction to Statistics
- What is Statistics?
- Why Statistics?
- Data Types
- Measures of Central Tendency
- Mean

- Median
- Mode
- Descriptive Statistics on

## **M2 - Inferential Statistics**

- Introduction to Inferential Statistics
- Hypothesis Testing
- Normal Distribution
- Confidence Interval
- P-value
- One-tailed and Two-tailed tests
- One Sample Z test
- One Sample T test
- Independent Sample T test
- Chi-square test
- Regression
- ANOVA

## **M3 - Inferential Statistics**

- Introduction to Inferential Statistics
- Hypothesis Testing
- Normal Distribution
- Confidence Interval
- P-value

- One-tailed and Two-tailed tests
- One Sample Z test
- One Sample T test
- Independent Sample T test
- Chi-square test
- Regression
- ANOVA

## **M4 - Regression**

- Introduction to Regression
- Linear Regression
- Simple Linear Regression
- Multiple Linear Regression
- Evaluation Metrics in Regression Models
- Logistic Regression
- Regularization: Ridge, Lasso, & Elastic Net

## **M5 - Predictive Analytics**

- Introduction to Predictive Analytics
- Predictive Analytics Workflow
- Data Collection and Preparation
- Exploratory Data Analysis (EDA)
- Feature Engineering and Selection
- Predictive Modeling Techniques

- Time Series Forecasting
- Evaluation and Performance Metrics
- Industry Applications and Use Cases

## **M6 - Regression**

- Introduction to Regression
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## **M7 - Predictive Analytics**

- Introduction to Predictive Analytics
- Predictive Analytics Workflow
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- Feature Engineering and Selection
- Predictive Modeling Techniques



# Applied Machine Learning Techniques

## M1 - Introduction to Machine Learning

- What is Machine Learning?
- Machine Learning Processes
- AI vs. Machine Learning vs. Deep Learning
- Significance of Machine Learning
- Applications of Machine Learning
- Myth about Machine Learning
- Types of Machine Learning
- Data Pre-processing Techniques
- Train/Test split method

## M2 - Supervised Learning - Regression

- Classification of Supervised Learning Algorithms
- Regression
- Linear Regression
- Assumptions of Linear Regression
- Types of Linear Regression
- OLS Regression Results Summary

- Calculation of  $R^2$
- Gradient Descent
- Regularization techniques

### **M3 - Evaluating Regression Models**

- Model Evaluation
- Scenario – BMI Prediction
- Bias-Variance Trade-off
- Learning and Validation Curves
- Techniques for Evaluating Regression Models
- Relative Standard Deviation
- Relative Squared Error
- Mean Absolute Error
- Relative Absolute Error
- Mean Squared Error
- Root Mean Squared Error on Prediction
- R-Square

### **M4 - Supervised Learning - Classification**

- What is Classification?
- Classification vs. Regression
- Types of Classification Algorithms
- Logistic Regression
- What is Logistic Regression?

- Log Odds
- Logistic Regression Cost Function
- Maximum Likelihood
- Evaluation Parameters

## **M5 - Decision Tree and Random Forest Models**

- Decision Tree
- Decision Tree using CART Algorithm
- Decision Tree using ID3 Algorithm
- Attribute Selection
- Random Forest

## **M6 - Mathematical and Bayesian Models**

- Naïve Bayes Classification
- Revisiting Bayes' Theorem
- Likelihood
- K-Nearest Neighbors (K-NN)
- Distance Metric
- Standardization (Normalization, Z-score)
- Choosing K
- Support Vector Machines (SVM)
- Linear SVM Classification
- Non-Linear SVM Classification
- SVM Regression

- Kernel SVM

## **M7 - Dimensionality Reduction**

- Curse of Dimensionality
- What is Dimensionality Reduction
- Why Dimensionality Reduction
- Feature Selection and Extraction
- Principal Component Analysis
- Eigen Vector/Singular Vector
- Eigen Value/Singular Value
- Scree Plot
- Linear Discriminant Analysis (LDA)
- Other Dimensionality Reduction Techniques

## **M8 - Unsupervised Learning using Clustering**

- What is Unsupervised Learning?
- What is Clustering?
- Types of Clustering
- Hierarchical Clustering
- Agglomerative Clustering
- Division Clustering
- K-Means Clustering
- Euclidean Distance
- Elbow Method

- Fuzzy C-Means Clustering
- DBSCAN Clustering

## **M9 - Model Evaluation and Hyperparameter Tuning**

- Model Selection
- Resampling Techniques
- Need for Model Evaluation
- Metrics for evaluating Regression Models
- Metrics for evaluating Classification Models
- Hyperparameter Tuning

## **M10 - Model Boosting and Optimization**

- Ensemble Learning
- Bagging
- Boosting
- AdaBoost
- Gradient Boosting
- XGBoost
- CatBoost
- Model Optimization
- Elements of Optimization
- Linear Programming
- Examples
- Applications

- Formulating Optimization
- Accelerated Gradient Methods
- Second-Order Methods

## **M11 - Association Rule Mining and Recommendation Engines (Self-paced)**

- Association Rule Mining
- Support
- Confidence
- Lift
- Apriori Algorithm
- Market Basket Analysis
- Recommendation Engine
- User-Based Collaborative Filtering (UBCF)
- Content-Based Filtering (CBF)

## **M12 - Time Series Analysis (Self-paced)**

- Time Series Analysis
- Components of Time Series
- Types of Data
- Stationary Data
- Non-Stationary Data
- Checks for Stationarity of Data
- Augmented Dicky Fuller Test
- Convert Non-Stationary Data to Stationary Data

- Differencing
- Seasonal Differencing
- Transformation
- Time Series Analysis Model

# Artificial Intelligence and Deep Learning

## M1 - Introduction to Text Mining and NLP

- Overview of Text Mining
- Need of Text Mining
- Natural Language Processing (NLP) in Text Mining
- Applications of Text Mining
- OS Module
- Reading, Writing to text and word files
- Setting the NLTK Environment
- Accessing the NLTK Corpora

## M2 - Extracting, Cleaning, and Preprocessing Text

- Tokenization
- Frequency Distribution
- Different Types of Tokenizers
- Bigrams, Trigrams & Ngrams
- Stemming
- Lemmatization
- Stopwords



- POS Tagging
- Named Entity Recognition

### **M3 - Analyzing Sentence Structure**

- Syntax Trees
- Chunking
- Chinking
- Context Free Grammars (CFG)
- Automating Text Paraphrasing

### **M4 - Text Classification-I**

- Machine Learning: Brush Up
- Bag of Words
- Count Vectorizer
- Term Frequency (TF)
- Inverse Document Frequency (IDF)

### **M5 - Text Classification-II**

- Converting Text to Features and Labels
- Multinomial Naive Bayes Classifier
- Leveraging Confusion Matrix

### **M6 - Introduction to Deep Learning**

- What is Deep Learning?
- Curse of Dimensionality

- Machine Learning vs. Deep Learning
- Use Cases of Deep Learning
- Human Brain vs. Neural Network
- What is Perceptron?
- Learning Rate
- Epoch
- Batch Size
- Activation Function
- Single Layer Perceptron

## **M7 - Getting Started with TensorFlow 2.0**

- Introduction to TensorFlow 2.x
- Installing TensorFlow 2.x
- Defining Sequence model layers
- Activation Function
- Layer Types
- Model Compilation
- Model Optimizer
- Model Loss Function
- Model Training
- Digit Classification using Simple Neural Network in TensorFlow 2.x
- Improving the model
- Adding Hidden Layer

- Adding Dropout
- Using Adam Optimizer

## **M8 - Convolution Neural Network**

- What is Convolution?
- Convolutional Layer Network
- Convolutional Layer
- Filtering
- ReLU Layer
- Pooling
- Data Flattening
- Fully Connected Layer
- Predicting a cat or a dog
- Saving and Loading a Model
- Face Detection using OpenCV

## **M9 - Regional CNN**

- Regional-CNN
- Selective Search Algorithm
- Bounding Box Regression
- SVM in RCNN
- Pre-trained Model
- Model Accuracy

- IoU
- RCNN – Speed Bottleneck
- Fast R-CNN
- RoI Pooling
- Fast R-CNN – Speed Bottleneck
- Faster R-CNN
- Feature Pyramid Network (FPN)
- Regional Proposal Network (RPN)
- Mask R-CNN

## **M0 - Boltzmann Machine and Autoencoder**

- What is Boltzmann Machine (BM)?
- Identify the issues with BM
- Why did RBM come into the picture?
- Step-by-step implementation of RBM
- Distribution of Boltzmann Machine
- Understanding Autoencoders
- Architecture of Autoencoders
- Brief on types of Autoencoders
- Applications of Autoencoders

## **M11 - Developing a Criminal Identification and Detection Application Using OpenCV**

- Why is OpenCV used?

- What is OpenCV
- Applications
- Build a Criminal Identification and Detection App

## **M12 - TensorFlow for Deployment**

- Use Case: Amazon's Virtual Try-Out Room.
- Why Deploy models?
- Model Deployment: Intuit AI models
- Model Deployment: Instagram's Image Classification Models
- What is Model Deployment
- Types of Model Deployment Techniques
- TensorFlow Serving
- Browser-based Models
- What is TensorFlow Serving?
- What are Servables?
- Demo: Deploy the Model in Practice using TensorFlow Serving
- Introduction to Browser based Models
- Deploy a Deep Learning Model in your Browser.

## **M13 - Project**

- Sentiment Classification

## **M14 - Emotion and Gender Detection (Self-paced)**

- Where do we use Emotion and Gender Detection?

- Emotion Detection architecture
- Face/Emotion detection using Haar Cascade
- Implementation on Colab

## **M15 - Introduction to RNN and GRU (Self-paced)**

- Issues with Feed Forward Network
- Recurrent Neural Network (RNN)
- Architecture of RNN
- Calculation in RNN
- Backpropagation and Loss calculation
- Applications of RNN
- Vanishing Gradient
- Exploding Gradient
- What is GRU?
- Components of GRU
- Update gate
- Reset gate
- Current memory content
- Final memory at current time step

## **M16 - LSTM (Self-paced)**

- What is LSTM?
- Structure of LSTM
- Forget Gate
- Output Gate

- LSTM architecture
- Types of Sequence-Based Model
- Sequence Prediction
- Sequence Classification
- Sequence Generation
- Types of LSTM
- Vanilla LSTM
- Stacked LSTM
- CNN LSTM
- Bidirectional LSTM
- How to increase the efficiency of the model?
- Backpropagation through time
- Workflow of BPTT

## **M17 - Auto Image Captioning Using CNN LSTM (Self-paced)**

- Auto Image Captioning
- COCO dataset
- Pre-trained model
- Inception V3 model
- The architecture of Inception V3
- Modify the last layer of a pre-trained model
- Freeze model
- CNN for image processing
- LSTM or text processing

# Generative AI and Large Language Models (LLMs)

## M1 - Generative AI and its Industry Applications

- Introduction to Generative AI
- Generative AI Principles
- Types of Generative Models
- Applications of Generative Models
- Machine Learning Algorithms with Gen AI
- Applications of Generative AI
- Ethical Considerations

## M2 - Autoencoders and GANs

- Basic Autoencoders
- Variational Autoencoders (VAEs)
- Applications in Data Compression and Generation
- Basic GAN Architecture
- Training GANs
- Variants of GANs
- DCGAN
- CycleGAN



## **M3 - Language Models and Transformer-based Generative Models**

- Exploring Language Models
- Types of Language Models
- Applications of Language Models
- The Transformer Architecture: Attention Mechanism
- Advanced Transformer Models
- GPT
- BERT
- Applications of Transformer-based Models

## **M4 - Working with ChatGPT**

- Introduction to ChatGPT
- Leveraging ChatGPT for Productivity
- Mastering Excel through ChatGPT
- Becoming a Data Scientist using ChatGPT
- Data Analysis in PowerBI with ChatGPT
- Creating a Content Marketing Plan
- Social Media Marketing using ChatGPT
- Keyword Search and SEO using ChatGPT
- Generating Content using ChatGPT
- Implementing ChatGPT for Customer Service
- ChatGPT for Developers
- ChatGPT for Creating Programs

- ChatGPT for Debugging
- ChatGPT for Integrating New Features
- ChatGPT for Testing
- Documenting the Code with ChatGPT

## **M5 - Prompting Techniques for Generative Models**

- Prompt Engineering Principles
- What is Prompt Engineering?
- Prompt Engineering with Generative AI models
- Tools for Prompt Engineering
- Prompt Design Strategies
- Types of Prompting
- Approaches for writing effective prompts
- Best practices for creating impactful prompts

## **M6 - Generative AI with LLMs**

- LLMs and Generative AI Project Lifecycle
- LLM Pre-Training and Scaling
- Fine-Tuning LLMs with Specific Instructions
- Efficient Fine-Tuning of Parameters
- Reinforcement Learning from Human Response

## **M7 - LLMs for Search, Prediction, and Generation**

- Search Query Completion
- Next Word Prediction

- Word Embeddings
- Transformers
- Generating Text
- Stacking Attention Layers

## **M8 - Interacting with Data using Retrieval-Augmented Generation**

- Understanding RAG
- RAG Architecture
- Retriever Techniques
- Keyword Matching
- Sentence Transformers
- LLM Integration with Prompt and Retrieved Information
- Augmentation Strategies
- Benefits of RAG
- Access to Real-time Information
- Improved Grounding and Factual Accuracy
- Advanced RAG: Moving Beyond Naive RAG
- Modular RAG
- Retrieval Quality Enhancement

## **M9 - LLMs for Word Embedding and Chunking Mechanism**

- Word Embedding Introduction
- Word Embedding Techniques

- Capturing Word Relationships
- Sentence Embedding Techniques
- Introduction to Vector Databases
- Different Types of Vector Databases
- Chunking
- Perform Chunking of the Document
- Traditional Chunking mechanism
- Advanced Chunking Mechanism
- Character Splitting
- Recursive Character splitting
- Document-based Chunking
- Semantic Chunking
- Agentic Chunking

## **M10 - LangChain and LlamaIndex for LLM Application Development**

- LangChain Framework
- Chaining LLMs with other AI Components for Complex Workflows
- Building Applications with Combined Functionalities
- LlamaIndex for Large-Scale Factual Knowledge Indexing for LLMs

## **M11 - Fine Tuning and Evaluating Generative Models**

- Fine Tuning Fundamentals
- Fine Tuning Techniques for Generative Models

- Data Augmentation
- Hyperparameter Tuning
- Curriculum Learning
- Transfer Learning
- PEFT (Parameter-Efficient Fine-Tuning)
- Low-Rank Adaptation (LoRA)
- Quantized LoRA (QLoRA)
- Feature Extraction
- Full Fine Tuning
- Selective Fine Tuning

## **M12 - Generative AI on Cloud**

- Cloud Computing Foundations
- AWS S3 in Generative AI
- Amazon EC2 Trn1n for Generative AI
- Amazon EC2 Inf2 for Generative AI
- Amazon Sagemaker for Generative AI
- Amazon CodeWhisperer
- Amazon Bedrock
- Azure OpenAI

## **M13 - Generative AI with Python**

- Python Code Generation with Generative AI

- Gen AI Tools for Coding
- Advanced Code Optimization with ChatGPT Gen AI Tool
- Coding with ChatGPT
- Building an Application in Python with ChatGPT

## **M14 - Industry Case Studies and Project**

- In-class Project: AI-Powered Text and Image Generator
- Case Study: Generative AI for Personalized Learning
- Case Study: Generative AI for Creative Content Generation
- Case Study: Generative AI for Business

## **M15 - Machine Learning with Generative AI (Self-paced)**

- Artificial Intelligence Essentials
- Disciplines of AI
- Types of AI
- Machine Learning Fundamentals
- Predictive ML Models
- ML Algorithms: Deep Dive
- Supervised Learning
- Unsupervised Learning
- Semi-Supervised Learning
- Reinforcement Learning

## M16 - Generative AI Tools (Self-paced)

- Hugging Face Transformers
- OpenAI GPT3 API
- Google Cloud AI Platform
- MidJourney
- DALL E-2
- Google Gemini

# Project Details

## Beginner

### Text Summarizer with AI

- Build an application that uses a pre-trained generative AI model to take a large text input and produce a summary.

### AI-Powered Image Caption Generator

- Create a basic tool that generates captions for images using a pre-trained generative AI model.

### AI-Driven Financial Stock Analysis

- Develop a tool to analyze financial stock data, extract insights, and provide summaries or predictions.

## Intermediate

### Personalized Media Recommendation System

- Develop a system for recommending material that takes user preferences into account when recommending books, movies, or other types of media.

### AI Chatbot for Customer Support

- Create a chatbot using a generative AI model that can respond appropriately to common customer service questions.



## Customer Review Sentiment Analyzer

- Build a tool that analyzes customer reviews and generates concise summaries of sentiments, identifying common themes and trends.

## Capstone

**Create a system that uses cutting-edge AI algorithms to extract insights and summaries from intricate financial reports.**

- Develop a system for recommending material that takes user preferences into account when recommending books, movies, or other types of media.

## AI-Driven Carbon Reduction Planner

- Create AI-driven carbon emission reduction plans suited to certain cities or industries.

## Advanced Personalized Health Insights Generator

- Build an AI system that generates detailed health reports by analyzing a patient's medical history, current data, and potential risk factors.



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