Foundations of Machine Learning

Target Audience: Students and Professionals Preparing for ML

Why This Course?

Machine Learning requires more than just coding skills—it demands a strong foundation in **mathematics, algorithms, and programming**. Many learners struggle with ML not because the concepts are too advanced, but because they lack the **mathematical intuition or coding fluency** needed to implement and understand the models.

This course bridges that gap. By combining **Python programming** with **essential mathematics for ML**, you will build the skills necessary to transition confidently into advanced machine learning.

By the end of this course, you will:

- Strengthen your Python skills for mathematical and algorithmic problem-solving.
- Gain mastery of the core math topics essential for ML.
- Implement mathematical concepts in Python through **coding exercises and projects**.
- Use **Git and GitHub** to manage and showcase your work.
- Be fully prepared to take on advanced ML algorithms and techniques.

What Will You Learn?

1. **Python Foundations for Math and ML**
   - Python programming for scientific computing.
   - Explore essential libraries: NumPy, Pandas, and matplotlib.
   - Work with Jupyter notebooks for experimenting with math and algorithms.
2. **Mathematical Foundations**
   - Linear Algebra: Vectors, matrices, operations, eigenvalues, and eigenvectors.
   - Probability & Statistics: Random variables, distributions, expectation, variance, hypothesis testing.
   - Calculus & Optimization: Derivatives, gradients, and the foundations of optimization methods.
3. **Algorithms for ML Preparation**
   - Implementation of classical algorithms in Python.
   - Time and space complexity (Big-O analysis).
   - Numerical methods relevant for ML.
4. **Optimization Methods**
   - Gradient descent: intuition, mathematics, and implementation.
   - Variants of gradient descent (stochastic, mini-batch).
   - Convergence, pitfalls, and practical considerations.
5. **Programming Practice & Projects**
   - Extensive hands-on coding throughout the course.

- Mini-projects to reinforce each major concept.
- Application-focused exercises linking math to ML.

6. **Git & Version Control**
   - Introduction to Git and GitHub.
   - Tracking changes, branching, and collaborative coding.
   - Building a GitHub portfolio of your projects.
7. **Additional Concepts as Needed**
   - Entropy and Information Gain (for decision trees).
   - Distance and Similarity Metrics (for kNN and clustering).
   - Log-Likelihood and Expectation (for probabilistic models).
   - Matrix Factorization and Eigen Decomposition (for dimensionality reduction).

Course Differentiators

- **24-week intensive program** combining depth and hands-on practice.
- Integrated approach combining **Python coding with mathematical rigor.**
- Heavy emphasis on **programming, projects, and practical problem-solving.**
- Git and GitHub usage throughout to instill **industry-ready practices**.
- Designed as a **bridge course** to prepare you for ML.

Course Benefits

- Build the **core math intuition** required for AI and ML.
- Develop **problem-solving skills** that connect theory to practice.
- Gain confidence by completing **mini-projects** and maintaining a GitHub portfolio.
- Be **ML-ready** by the end of the course, with a solid foundation to tackle advanced topics.

Who Should Enroll?

- Students aiming to pursue ML or AI.
- Professionals looking to strengthen their math and coding foundations.
- Learners who want to confidently bridge the gap between Python programming and ML.

Course Duration: 24 weeks /48 weeks
Mode: Online

Instructor Support: Live sessions and Q&A opportunities

Get ML-Ready with Python and Math

This course gives you the tools to **connect coding, math, and algorithms**, setting you up for success in advanced machine learning.

Master AI & Machine Learning
From Fundamentals to Advanced Practice
A Comprehensive 24-Week Deep Dive for Software Professionals

Go beyond the basics and become a proficient AI & Machine Learning practitioner. This extended, in-depth course is meticulously designed for developers, testers, team leads, and software professionals aiming for a robust skill set and a confident transition into specialized AI/ML roles.

Course Principles & Objectives

- **Mastery Through Depth & Breadth:** Build a comprehensive understanding, covering not just core concepts but also advanced algorithms, specialized domains (NLP, CV), practical MLOps, and ethical considerations.
- **Rigorous Conceptual Foundations:** Gain deep intuition behind the math and algorithms, enabling you to innovate, troubleshoot complex problems, and critically evaluate different approaches.
- **Dual Framework Proficiency:** Achieve practical mastery in **both** major Deep Learning frameworks: **PyTorch *and* TensorFlow/Keras**.
- **Production-Ready Skills:** Focus on the entire ML lifecycle, including robust evaluation, experiment tracking, versioning, deployment strategies, and monitoring concepts (MLOps).
- **Strategic Career Advancement:** Equip yourself with the advanced knowledge and extensive portfolio needed to target specialized AI/ML engineer, data scientist, or research-oriented roles.

Benefits & Your Capabilities

- **Build an Extensive, High-Impact Portfolio:** Complete numerous sophisticated projects covering diverse ML/DL tasks, including NLP, Computer Vision, and potentially Generative Models, showcasing advanced capabilities.
- **Command Advanced ML & DL Techniques:** Confidently implement, evaluate, and tune a wide array of algorithms: Linear/Logistic Models, SVM, Naive Bayes, Tree Ensembles (Random Forests, XGBoost, LightGBM), Advanced Unsupervised Learning, Anomaly Detection, and complex Deep Learning architectures (CNNs, RNNs/LSTMs, **Transformers**).
- **Become Framework Fluent:** Seamlessly work with both **PyTorch** and **TensorFlow/Keras**, understanding their strengths and choosing the right tool for the job.
- **Implement End-to-End MLOps Practices:** Apply practical skills in experiment tracking (MLflow/W&B), data/model versioning (DVC concept), advanced evaluation, monitoring concepts, and diverse deployment strategies (APIs, Docker, Cloud Platforms Intro).
- **Specialize in High-Demand Areas:** Gain significant practical experience in **Natural Language Processing (NLP)** using Transformers and the Hugging Face ecosystem, and **Advanced Computer Vision (CV)** including Object Detection/Segmentation concepts.
- **Champion Responsible AI:** Understand and apply techniques for fairness assessment, model explainability (SHAP/LIME), bias mitigation, and ethical AI development.

- **Accelerate Your AI/ML Career:** Possess the deep knowledge and practical skills to stand out in the job market, targeting a wider range of AI/ML roles and contributing at a higher level.

Course Content Highlights

- **Modules 1-2: In-Depth Foundations & Advanced Data Techniques:**
  - *Principles:* ML Lifecycle Mastery, Advanced EDA, Robust Data Cleaning/Preprocessing, Feature Engineering & Selection Strategies, Advanced Math Intuition (Linear Algebra, Calculus, Probability/Stats).
  - *Tools:* Python (NumPy, Pandas), Visualization Libraries, Scikit-learn Advanced Features.
- **Modules 3-5: Comprehensive Supervised & Unsupervised Learning:**
  - *Principles:* Deep Dive into Linear Models, SVM Margins & Kernels, Probabilistic Classification (Naive Bayes), Instance-Based Learning (KNN), Advanced Tree Ensembles & Boosting Algorithms (GBM, XGBoost), Advanced Clustering (DBSCAN), Anomaly Detection, Dimensionality Reduction (PCA, t-SNE/UMAP).
  - *Tools:* Scikit-learn, XGBoost, LightGBM.
- **Module 6: Deep Learning Mastery (Dual Framework):**
  - *Principles:* Advanced NN Training (Optimization, Backpropagation nuances, Regularization deep dive), Architectural Patterns.
  - *Tools:* **PyTorch** AND **TensorFlow/Keras** (Extensive practical coverage in both).
- **Module 7: Advanced Computer Vision (CV):**
  - *Principles:* Advanced CNN Architectures (ResNet concept), Transfer Learning (Feature Extraction vs. Fine-Tuning), Object Detection & Image Segmentation Fundamentals.
  - *Tools:* PyTorch/Keras, torchvision, tf.keras.applications.
- **Module 8: Natural Language Processing (NLP) with Transformers:**
  - *Principles:* Word Embeddings (Word2Vec/GloVe), Sequence Modeling (LSTMs), Attention Mechanisms, **Transformer Architecture**, Pre-trained Models (BERT/GPT concepts), **Fine-tuning Transformers** for downstream tasks.
  - *Tools:* PyTorch/Keras, **Hugging Face transformers**, Tokenizers.
- **Module 9: Introduction to Generative Models:**
  - *Principles:* Autoencoders, Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs) concepts.
- **Module 10: Practical MLOps:**
  - *Principles:* Experiment Tracking, Code/Data/Model Versioning, ML Testing, Monitoring for Drift, Deployment Strategies (APIs, Containers, Cloud), CI/CD concepts for ML.
  - *Tools:* MLflow/W&B, DVC concept, Docker concept, Cloud Platform Intro (AWS/GCP/Azure).
- **Module 11: Responsible AI in Practice:**

- *Principles:* Fairness Metrics, Explainability Techniques (SHAP/LIME), Bias Mitigation Strategies, Privacy Concepts.
- *Tools:* SHAP/LIME libraries.

Learning Approach

- Immersive live online sessions (2 x 2 hours per week for deeper engagement).
- Extensive hands-on coding demonstrations in **both PyTorch and TensorFlow/Keras**.
- Challenging programming assignments and a substantial, multi-faceted portfolio.
- Emphasis on deep conceptual understanding, mathematical intuition, and practical trade-offs.
- Comprehensive capstone project allowing for specialization (e.g., NLP, CV, MLOps focus).

Prerequisites: Solid programming experience (any language - Python covered). Familiarity with basic software development concepts. No prior ML experience required, but a strong desire to learn is essential.

Invest in Your Future. Become an AI/ML Expert.

Course Duration: 24 weeks . Total course duration - 48 weeks
Mode: Online
Instructor Support: Live sessions, one-on-one feedback, and project reviews