**🚀 AI & Data Science Engineer Roadmap**

**🔹 Phase 1: Prerequisites (Mathematics & Programming)**

Before diving into AI & Data Science, you must have a solid foundation in **Mathematics** and **Programming**.

**📌 1. Learn Python (Quick Recap)**

* Python Basics
* OOP in Python
* Python Libraries: NumPy, Pandas, Matplotlib, Seaborn

**📌 2. Mathematics for AI & Data Science**

* **Linear Algebra**
  + Vectors, Matrices, and Tensor Operations
  + Eigenvalues and Eigenvectors
* **Probability & Statistics**
  + Mean, Variance, Standard Deviation
  + Probability Distributions (Normal, Poisson, Binomial)
  + Hypothesis Testing
* **Calculus**
  + Differentiation & Integration
  + Gradient Descent

**🔹 Phase 2: Data Handling & Visualization**

**🔹 Learn Data Science Libraries**

* NumPy: Handling numerical data
* Pandas: Data manipulation
* Matplotlib & Seaborn: Data visualization

**🔹 Data Preprocessing**

* Handling missing values, duplicates
* Feature Engineering
* Scaling & Normalization

**🔹 Data Visualization Techniques**

* Bar plots, Histograms, Scatter plots
* Heatmaps, Boxplots

**🔹 Phase 3: Machine Learning (ML)**

**🔹 Supervised Learning**

* Linear Regression, Logistic Regression
* Decision Trees, Random Forests
* Support Vector Machines (SVM)

**🔹 Unsupervised Learning**

* K-Means Clustering
* Principal Component Analysis (PCA)
* Anomaly Detection

**🔹 Model Evaluation**

* Train/Test Split, Cross-validation
* Precision, Recall, F1 Score

**🔹 Python Libraries**

* scikit-learn: ML models
* XGBoost, LightGBM: Advanced ML

**🔹 Phase 4: Deep Learning & Neural Networks**

**🔹 Fundamentals of Deep Learning**

* Neural Networks (ANNs)
* Backpropagation & Optimization
* Activation Functions (ReLU, Sigmoid, Softmax)

**🔹 Convolutional Neural Networks (CNNs) – Computer Vision**

* Image Classification (CNN, ResNet)
* Object Detection (YOLO, Faster R-CNN)
* Transfer Learning

**🔹 Recurrent Neural Networks (RNNs) – NLP**

* Sequence Modeling
* LSTMs, GRUs
* Transformers (BERT, GPT)

**🔹 Deep Learning Libraries**

* TensorFlow & Keras
* PyTorch

**🔹 Phase 5: Advanced AI Topics & Specialization**

**🔹 Reinforcement Learning**

* Markov Decision Process (MDP)
* Q-Learning, Deep Q Networks (DQN)
* Policy Gradient Methods

**🔹 Natural Language Processing (NLP)**

* Tokenization, Word Embeddings (Word2Vec, GloVe)
* Attention Mechanisms, Transformers
* Chatbots & Language Models

**🔹 Generative AI & Large Models**

* GANs (Generative Adversarial Networks)
* Stable Diffusion, DALL·E
* Large Language Models (LLMs)

**🔹 Big Data & Cloud Technologies**

* Apache Spark, Hadoop
* Google Cloud AI, AWS SageMaker
* Data Lakes & Pipelines

**🔹 Phase 6: AI & Data Science Project Development**

* Work on real-world datasets (Kaggle, UCI, etc.)
* Build end-to-end projects: Data Cleaning → Model Training → Deployment
* Use **Docker, FastAPI, Flask** for ML model deployment
* Use **MLflow, Weights & Biases** for model tracking

**🔹 Phase 7: Career Growth & Continuous Learning**

**🔹 Get Industry Experience**

* Work on **AI projects** & contribute to **open-source**
* Take part in **AI competitions (Kaggle, DrivenData)**
* Build a **portfolio (GitHub, personal website)**

**🔹 Stay Updated**

* Follow AI research papers
* Learn about AI Ethics & Explainability (SHAP, LIME)

**🎯 Final Goal: AI & Data Science Engineer**

By following this roadmap, you'll gain the necessary skills to become a successful **AI & Data Science Engineer** 🚀