**Comprehensive Study Plan for Learning ML, NLP, DL, and CV with Minimal Math**

**Phase 1: Introduction and Fundamentals**

**Goal: Understand the landscape of ML, NLP, and DL with minimal math.**

1. **Overview of AI, ML, and DL**:
   * **YouTube**: [Artificial Intelligence, Machine Learning & Deep Learning Explained](https://www.youtube.com/watch?v=JonnQuQDThc&ab_channel=Simplilearn) by Simplilearn.
   * **YouTube**: [A Gentle Introduction to Machine Learning](https://youtu.be/Gv9_4yMHFhI?list=PLblh5JKOoLUICTaGLRoHQDuF_7q2GfuJF) by StatQuest.
   * **Blog**: <https://developers.google.com/machine-learning/crash-course> Google Crash Couse on Machine Learning
   * **Book**: [*The Hundred-Page Machine Learning Book* by Andriy Burkov](https://freecomputerbooks.com/The-Hundred-Page-Machine-Learning-Book.html) (Minimal math, highly intuitive).
2. **Python Basics**:
   * **Free Course**: [Python for Data Science by Kaggle](https://www.kaggle.com/learn/python).
   * **YouTube**: [Python Full Course for Beginners](https://www.youtube.com/watch?v=_uQrJ0TkZlc&ab_channel=ProgrammingwithMosh) by Programming with Mosh.
3. **Essential Math for ML**:
   * Linear Algebra:
     + **YouTube**: [Essence of Linear Algebra](https://www.youtube.com/watch?v=fNk_zzaMoSs&list=PLZHQObOWTQDPD3MizzM2xVFitgF8hE_ab&ab_channel=3Blue1Brown) by 3Blue1Brown.
   * Statistics:
     + **YouTube**: [Statistics Fundamentals](https://www.youtube.com/watch?v=qBigTkBLU6g&list=PLblh5JKOoLUK0FLuzwntyYI10UQFUhsY9) by StatQuest.
   * Probability:
     + **YouTube**: [Introduction to Probability](https://www.youtube.com/watch?v=qaFNhwNBY3k&list=PLIeGtxpvyG-I9m4otjYGCQL_1m0Edm0LA&pp=iAQB) by BrandonFoltz.
     + **YouTube**: [Continuous Probability Distribution](https://www.youtube.com/watch?v=aCW8wm6nrRw&list=PLIeGtxpvyG-KdqFkNrED9w8j9dEMMLj7e&pp=iAQB) by BrandonFoltz.
     + **YouTube**: [Discrete Probability Distribution](https://www.youtube.com/watch?v=rifK8BtHaYI&list=PLIeGtxpvyG-LWd2IOW1wveszJXy_aHytX&pp=iAQB) by BrandonFoltz.
     + **YouTube**: [Probability](https://www.youtube.com/watch?v=kqSzLo9fenk&list=PLs8w1Cdi-zvbv6iq6Xu01PgflKmMDRMDl) by SerranoAcademy
   * Calculus:
     + **YouTube**: [Calculus for Machine Learning](https://www.youtube.com/watch?v=XiSKgypqW3Q) by StatQuest.
     + **YouTube:** [Essene of Calculus](https://www.youtube.com/watch?v=WUvTyaaNkzM&list=PLZHQObOWTQDMsr9K-rj53DwVRMYO3t5Yr) by 3Blue1Brown.
     + **YouTube:** [Differential equations](https://www.youtube.com/watch?v=p_di4Zn4wz4&list=PLZHQObOWTQDNPOjrT6KVlfJuKtYTftqH6) by3Blue1Brown.
     + **Book**: [Calculus for Machine Learning](https://danielvoconnor.github.io/MathNotes/calcForMachineLearning.pdf) by Daniel O’Connor.

**Time Commitment: 2–3 weeks.**

**Phase 2: Machine Learning**

**Goal: Gain a practical understanding of supervised and unsupervised ML algorithms.**

* **Supervised Learning**:
  + Regression (Linear and Logistic):
    - **YouTube**: [Linear Regression, The Very Basics](https://www.youtube.com/watch?v=ZkjP5RJLQF4)  by BrandonFoltz.
    - **YouTube:** [Logistic Regression and Linear Models](https://www.youtube.com/watch?v=2AQKmw14mHM&list=PLblh5JKOoLUIzaEkCLIUxQFjPIlapw8nU) by StatQuest.
    - **YouTube**: [Linear Regression: A friendly introduction](https://youtu.be/wYPUhge9w5c?list=PLs8w1Cdi-zvZXi_mhx9l484p3OkNmiZZe) by SerranoAcademy
    - **YouTube**: [Multiple Linear Regression](https://www.youtube.com/watch?v=dQNpSa-bq4M&list=PLIeGtxpvyG-IqjoU8IiF0Yu1WtxNq_4z-) by BrandonFoltz.
    - **YouTube**: [Nonlinear Regression](https://www.youtube.com/watch?v=Rb8MnMEJTI4&list=PLIeGtxpvyG-KE0M1r5cjbC_7Q_dVlKVq4) by BrandonFoltz.
    - **YouTube:** [Logistic Regression](https://www.youtube.com/watch?v=zAULhNrnuL4&list=PLIeGtxpvyG-JmBQ9XoFD4rs-b3hkcX7Uu) by BrandonFoltz.
    - **YouTube:** [Logistic Regression](https://www.youtube.com/watch?v=yIYKR4sgzI8&list=PLblh5JKOoLUKxzEP5HA2d-Li7IJkHfXSe) by StatQuest.
    - **YouTube**: [Logistic Regression: A friendly introduction](https://www.youtube.com/watch?v=jbluHIgBmBo&list=PLs8w1Cdi-zvZXi_mhx9l484p3OkNmiZZe&index=2&pp=iAQB) by SerranoAcademy
    - **Hands-on**: Implement using [Scikit-learn Linear Regression Tutorial](https://scikit-learn.org/stable/auto_examples/linear_model/plot_ols.html).
  + Decision Trees and Random Forest:
    - **YouTube**: [Decision and Classification Trees](https://www.youtube.com/watch?v=_L39rN6gz7Y&list=PLblh5JKOoLUKAtDViTvRGFpphEc24M-QH) by StatQuest.
    - **YouTube**: [Decision Trees: A Friendly Introduction](https://www.youtube.com/watch?v=HkyWAhr9v8g&list=PLs8w1Cdi-zvZXi_mhx9l484p3OkNmiZZe&index=4&pp=iAQB) by SerranoAcademy
    - **YouTube**: [Random Forests](https://www.youtube.com/watch?v=J4Wdy0Wc_xQ&list=PLblh5JKOoLUIE96dI3U7oxHaCAbZgfhHk) by StatQuest.
  + Support Vector Machine:
    - **YouTube**: [Support Vector Machines](https://www.youtube.com/watch?v=efR1C6CvhmE&list=PLblh5JKOoLUL3IJ4-yor0HzkqDQ3JmJkc) by StatQuest.
    - **YouTube**: [Support Vector Machines](https://www.youtube.com/watch?v=Lpr__X8zuE8&list=PLs8w1Cdi-zvZXi_mhx9l484p3OkNmiZZe&index=3&pp=iAQB): A Friendly Introduction by SerranoAcademy
  + **XGBoost**:
  + **YouTube**: [XGBoost](https://www.youtube.com/watch?v=OtD8wVaFm6E&list=PLblh5JKOoLULU0irPgs1SnKO6wqVjKUsQ) by StatQuest.
  + **Tutorial**: [XGBoost Python Documentation](https://xgboost.readthedocs.io/en/stable/).
* **Unsupervised Learning**:
  + Clustering:
    - **YouTube**: [Gausian Mixture Models](https://www.youtube.com/watch?v=q71Niz856KE&list=PLs8w1Cdi-zvZGyT2Rt0ieA0G6xGUqn3Xw&index=1&pp=iAQB) by SerranoAcademy
    - **YouTube**: [K-Means Clustering](https://www.youtube.com/watch?v=4b5d3muPQmA) by StatQuest.
    - **YouTube**: [Hierarchical Clustering](https://www.youtube.com/watch?v=8QCBl-xdeZI) by DATAtab.
    - **YouTube**: [Clustering with DBSCAN](https://www.youtube.com/watch?v=RDZUdRSDOok&ab_channel=StatQuestwithJoshStarmer) by StatQuest
    - **YouTube**: [Clustering: K-Means and Clustering](https://www.youtube.com/watch?v=QXOkPvFM6NU&list=PLs8w1Cdi-zvZGyT2Rt0ieA0G6xGUqn3Xw&index=2&pp=iAQB) by SerranoAcademy
    - **YouTube**: [Clustering](https://www.youtube.com/playlist?list=PLdbi1El7_of_-w5GM97DH4X504vD0Md1V) in Machine Learning Explained by Data & Analytics.
  + Dimensionality Reduction (PCA):
    - **YouTube**: [Principal Component Analysis](https://www.youtube.com/watch?v=FgakZw6K1QQ) (PCA), Step-by-Step by StatQuest.
    - **YouTube**: [Principal Component Analysis](https://www.youtube.com/watch?v=g-Hb26agBFg&list=PLs8w1Cdi-zvZGyT2Rt0ieA0G6xGUqn3Xw&index=3&pp=iAQB) by SerranoAcademy
    - **YouTube**: [Latent Dirichlet Allocation](https://www.youtube.com/watch?v=T05t-SqKArY&list=PLs8w1Cdi-zvZGyT2Rt0ieA0G6xGUqn3Xw&index=5&pp=iAQB) (LDA) by SerranoAcademy
    - **YouTube**: Training Latent Dirichlet Allocation: Gibbs Sampling by SerranoAcademy
  + Singular Value Decomposition (SVD):
    - **YouTube**: [Singular Value Decomposition and Image Compression](https://www.youtube.com/watch?v=DG7YTlGnCEo&list=PLs8w1Cdi-zvZGyT2Rt0ieA0G6xGUqn3Xw&index=8&pp=iAQB) by SerranoAcademy
  + Generative Models:
    - **YouTube**: [Variational Autoencoders (VAE) and denoisingssion](https://www.youtube.com/watch?v=SSXDkfiPs7c&list=PLs8w1Cdi-zvZGyT2Rt0ieA0G6xGUqn3Xw&index=9&pp=iAQB) by SerranoAcademy
    - **YouTube**: [Generative Adverserial Networks](https://www.youtube.com/watch?v=8L11aMN5KY8&list=PLs8w1Cdi-zvZGyT2Rt0ieA0G6xGUqn3Xw&index=10&pp=iAQB) (GAN) by SerranoAcademy
    - **YouTube**: [Gaussian Mixture Models](https://www.youtube.com/watch?v=wT2yLNUfyoM&ab_channel=DataMListic) by DataMListic
* **Evaluation Techniques**:
* Cross-validation, precision, recall, F1-score:
  + - **YouTube**: [How to evaluate a classifier in scikit-learn](https://www.youtube.com/watch?v=85dtiMz9tSo&ab_channel=DataSchool) by DataSchool and [Github Link](https://github.com/justmarkham/scikit-learn-videos) and [Course Link](https://courses.dataschool.io/introduction-to-machine-learning-with-scikit-learn).
    - **YouTube**: [Machine Learning: Testing and Error Metrics](https://youtu.be/aDW44NPhNw0?list=PLs8w1Cdi-zvY9ICoYqu1XV0YoTQgShXw2) by SerranoAcademy
* **Books and Tutorials**:
  + Book: *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow* by Aurélien Géron.
  + Kaggle Tutorial: [Intro to Machine Learning](https://www.kaggle.com/learn/intro-to-machine-learning).

#### ****Hands-On****:

* **Project**: Predict house prices using XGBoost or classify customer churn.
* **Tool**: Use Scikit-learn and [XGBoost](https://xgboost.readthedocs.io/en/stable/).

**Time Commitment: 4–5 weeks.**

**Phase 3: Natural Language Processing (NLP)**

**Goal: Understand the basics of text processing and NLP techniques.**

1. **Basics of Text Processing**:
   * Tokenization, Stemming, Lemmatization, and Parts of Speech (POS):
     + **YouTube**: [Introduction to NLTK: Tokenization, Stemming, Lemmatization, POS Tagging](https://www.geeksforgeeks.org/introduction-to-nltk-tokenization-stemming-lemmatization-pos-tagging/)  by Geek for Geeks.
     + **YouTube**: [All about Tokenization, Stop words, Stemming and Lemmatization in NLP](https://medium.com/@abhishekjainindore24/all-about-tokenization-stop-words-stemming-and-lemmatization-in-nlp-1620ffaf0f87)  by Abhishek Jain.
     + **YouTube**: [NLP: Tokenization, Stemming, Lemmatization and Part of Speech Tagging](https://keremkargin.medium.com/nlp-tokenization-stemming-lemmatization-and-part-of-speech-tagging-9088ac068768)  by Kerem Kargın
     + **Hands-on**: Use [NLTK](https://www.nltk.org/) or [spaCy](https://spacy.io/usage).
2. **Feature Extraction**:
   * Bag of Words and TF-IDF:
     + **YouTube**: Using TF-IDF to convert unstructured text to useful features by Mike Bernico.
     + **YouTube**: [Natural Language Processing with spaCy and Python for Beginners](https://www.youtube.com/watch?v=dIUTsFT2MeQ&ab_channel=freeCodeCamp.org) by feeCodeCamp
3. **Word Embeddings**:
   * Word2Vec, GloVe:
     + **YouTube**: [The Illustrated Word2vec - A Gentle Intro to Word Embeddings in Machine Learning](https://www.youtube.com/watch?v=ERibwqs9p38&ab_channel=StanfordUniversitySchoolofEngineering) by Jay Alammar and [Link](https://jalammar.github.io/illustrated-word2vec/).
     + **YouTube**: [Word Vector Representations: word2vec](https://www.youtube.com/watch?v=ERibwqs9p38&ab_channel=StanfordUniversitySchoolofEngineering) by Stanford University.
     + **YouTube**:  [GloVe: Global Vectors for Word Representation](https://youtu.be/ASn7ExxLZws) by Stanford University
     + **Hands-on**: Use [Gensim Tutorial](https://radimrehurek.com/gensim/auto_examples/index.html).
4. **Advanced NLP Techniques**:
   * Named Entity Recognition (NER):
     + **Hands-on**: [spaCy NER Tutorial](https://spacy.io/usage/training).
   * Sentiment Analysis:
     + **Hands-on**: [Kaggle Sentiment Analysis Dataset](https://www.kaggle.com/c/sentiment-analysis-on-movie-reviews).

**Web:**

* [**NLP Course**](https://huggingface.co/learn/nlp-course/chapter1/1) by Hugging Face

**Books:**

* *Natural Language Processing with Python* by Steven Bird.
* Transformers for NLP by Denis Rothman.
* *Speech and Language Processing* by Jurafsky and Martin (Reference).

**Time Commitment: 4–5 weeks.**

**Phase 4: Deep Learning Fundamentals**

**Goal: Understand neural networks, optimization, and basic architectures.**

1. **Core Concepts**:
   * Neural Networks:
     + **YouTube**: [What is a Neural Network?](https://www.youtube.com/watch?v=aircAruvnKk&list=PLZHQObOWTQDNU6R1_67000Dx_ZCJB-3pi) by 3Blue1Brown.
     + **YouTube**:  [Neural Network/Deep Learning](https://www.youtube.com/playlist?list=PLblh5JKOoLUIxGDQs4LFFD--41Vzf-ME1) by StatQuest.
2. **Architectures**:
   * Convolutional Neural Networks (CNNs):
     + **YouTube**: [Convolutional Neural Networks Explained](Convolutional%20Neural%20Networks%20(CNNs)%20explained) by deeplizard.
   * Recurrent Neural Networks (RNNs, LSTMs):
     + **YouTube**: [Recurrent Neural Networks (RNN) and Long Short-Term Memory (LSTM)](https://www.youtube.com/watch?v=WCUNPb-5EYI&ab_channel=BrandonRohrer) by Brandon Rohrer.
3. **Optimization Techniques**:

* Backpropagation, Gradient Descent:
  + **YouTube**: [Optimization for Deep Learning (Momentum, RMSprop, AdaGrad, Adam)](Optimization%20for%20Deep%20Learning%20(Momentum,%20RMSprop,%20AdaGrad,%20Adam)) by DeepBean.
  + **YouTube**: [Deep Learning Optimizers](https://www.youtube.com/playlist?list=PLKnIA16_RmvYhD5pqAeVu3j_jTjnTJIW2) by CampusX.

1. **Key Aspects of Deep Learning**:

* Various FAQs (why batch normalization works, why does RNN suffer from vanishing gradient etc):
  + **YouTube**: [Deep Learning queries](https://www.youtube.com/watch?v=JjKLkY-b0aI&list=PL8hTotro6aVFIeK6Ov8_f-BLQjdpi8wTT&ab_channel=DataMListic) by DataMListic.

1. **Practical Frameworks**:
   * TensorFlow/Keras:
     + **Hands-on**: [Deep Learning with Keras Tutorial](https://www.tensorflow.org/tutorials/keras/classification).
   * PyTorch:
     + **YouTube**: [PyTorch Basics](https://www.youtube.com/watch?v=V_xro1bcAuA) by FreeCodeCamp.

**Hands-On**:

* Use TensorFlow/Keras or PyTorch for MNIST digit classification.
* Train a basic CNN for image classification on CIFAR-10.

**Books:**

* *Deep Learning for Coders with Fastai and PyTorch* by Jeremy Howard.
* *Deep Learning* by Ian Goodfellow (For in-depth study).

**Time Commitment: 4–5 weeks.**

**Phase 5: Transformers and Advanced DL**

**Goal: Grasp modern NLP with Transformers and state-of-the-art techniques.**

1. **Transformer Models**:
   * Self-Attention and Transformer Architecture:
     + **YouTube**: [Attention is All You Need](https://www.youtube.com/watch?v=OYygPG4Z9tA) by Yannic Kilcher.

* BERT, GPT:
  + - **YouTube**: [The Narrated Transformer Language Model](https://www.youtube.com/watch?v=-QH8fRhqFHM) **by Jay Alammar.**
    - **Link**: [Transformers Simplified](https://jalammar.github.io/illustrated-transformer/) by Jay Alammar.
  + Hands-on with Hugging Face:
    - **Tutorial**: [Hugging Face Transformers Course](https://huggingface.co/transformers/).
  + Fine-Tuning Models:
    - **Hands-on**: [Fine-Tuning a Pre-Trained BERT](https://huggingface.co/transformers/training.html).
* Hands-On:
* Use Hugging Face library to fine-tune a transformer for sentiment analysis:
  + Hugging Face Course.

1. **State-of-the-Art Projects**:
   * Text Generation (GPT-2/GPT-3).
   * Summarization and Translation.

**Books:**

* *Transformers for NLP* by Denis Rothman.
* *Natural Language Processing with Python* by Steven Bird.
* *Natural Language Processing with Transformers* by Lewis Tunstall et al.

**Time Commitment: 4–5 weeks.**

### ****Phase 6: Computer Vision****

#### ****Goal****: Learn CV basics and advanced object detection.

1. **Image Processing with OpenCV**:
   * Basic Operations: Resize, crop, blur:
     + **YouTube**: [OpenCV Basics](https://www.youtube.com/watch?v=oXlwWbU8l2o) using Python by Murtaza’s Workshop (freeCodeCamp).
     + **YouTube**: [Deep Learning for Computer Vision with Python and TensorFlow – Complete Course](https://www.youtube.com/watch?v=IA3WxTTPXqQ&ab_channel=freeCodeCamp.org) by Murtaza’s Workshop (freeCodeCamp).
2. **Object Detection**:
   * YOLO and SSD:
     + **YouTube**: [YOLO Object Detection](https://www.youtube.com/watch?v=YmMZkCstui0&ab_channel=AugmentedAI) by Augmented AI
     + **YouTube**: [YOLOv8 Full Tutorial](https://www.youtube.com/watch?v=Z-65nqxUdl4&list=PLb49csYFtO2FXGMZxqmPrw_0GPJnPR0Up&ab_channel=Computervisionengineer) Detection, Classification, Segmentation, Pose by Computer vision engineer
     + **YouTube**: [Tensorflow Object Detection in 5 Hours with Python](https://www.youtube.com/watch?v=yqkISICHH-U&ab_channel=NicholasRenotte) by Nicholas Renotte
3. **Segmentation**:
   * Mask R-CNN for instance segmentation:
     + **Hands-On**: [Mask R-CNN in PyTorch](https://github.com/matterport/Mask_RCNN).
4. **Vision Transformers (ViTs)**:
   * **YouTube**: [Vision Transformers Explained](https://www.youtube.com/watch?v=ovB0ddFtzzA) by Yannic Kilcher (mildlyoverfitted).
   * Hands-On:
     + Use Hugging Face's Vision Transformer models.

**Web**:

* [**Community Computer Vision Course**](https://huggingface.co/learn/computer-vision-course/unit0/welcome/welcome) by Hugging Face

**Books**:

* + Deep Learning for Computer Vision by Adrian Rosebrock.

#### ****Time Commitment****: 4–5 weeks.

### ****Phase 7: Advanced Topics****

#### ****Goal****: Gain exposure to state-of-the-art techniques.

1. **Generative Adversarial Networks (GANs)**:
   * **YouTube**: [A Friendly Introduction to Generative Adversarial Networks (GANs)](https://www.youtube.com/watch?v=8L11aMN5KY8) by SerranoAcademy.
   * Hands-On:
     + Implement a DCGAN using TensorFlow.
2. **Self-Supervised Learning**:
   * Learn modern techniques like SimCLR and BYOL:
     + **Blog**: Self-Supervised Learning Explained.
3. **Reinforcement Learning (Optional)**:
   * Deep Reinforcement Learning:
     + **YouTube**: [Deep Reinforcement Learning](https://youtu.be/IUiKAD6cuTA) by SteveBrunton.
   * Basics of Q-Learning:
     + **YouTube**: [Q Learning simply Explained](https://www.youtube.com/playlist?list=PLudTRP_Ek2aSi6ZBOKShVm7T1Uod6mBbQ) by Marcus Koseck.
     + **YouTube**: [Q-Learning: Model Free Reinforcement Learning and Temporal Difference Learning](https://www.youtube.com/watch?v=0iqz4tcKN58&ab_channel=SteveBrunton) by Steve Brunton.
4. **Large Language Models (LLM)**
   * LLM:
     + **YouTube**: [Large Language Models](https://www.youtube.com/watch?v=OxCpWwDCDFQ&list=PLs8w1Cdi-zva4fwKkl9EK13siFvL9Wewf) by SerranoAcademy
     + **YouTube**: [NLP and LLMs](https://www.youtube.com/watch?v=OxCpWwDCDFQ&list=PLs8w1Cdi-zvYskDS2icIItfZgxclApVLv) by by SerranoAcademy

### ****Phase 8: Apply Knowledge****

#### ****Goal****: Build projects that integrate multiple concepts.

1. **Project Ideas**:
   * ML: Build a recommendation system with XGBoost.

Predict house prices or customer churn.

* + NLP: Create a chatbot using transformers.

Sentiment analysis for social media.

* + DL: Image classification or chatbot using Transformers.
  + CV: Train an object detection model using YOLO.

1. **Resources**:
   * **Kaggle**: Competitions.
   * **GitHub**: Explore open-source projects.