

# DataQuest Solutions

## Deep Learning using Python

### Lesson 1. Foundations of Deep Learning

- Neural Networks Basics
  - Perceptrons
  - Activation Functions (ReLU, Sigmoid, Tanh, Softmax)
- Loss Functions: MSE, Cross-Entropy Loss
- Optimization
  - Gradient Decent
  - Stochastic Gradient Decent
  - Adam, RMSprop, Adagrad optimizers
- Back Propagation
  - Chain rule
  - Weight updates

### Lesson 2. Mathematical Background

- Linear Algebra (Vectors, Matrices, Operations)
- Calculus (derivatives, chain rule)
- Probability and Statistics (for uncertainty, regularization)
- Basic Information Theory (entropy, KL divergence)

### Lesson 3. Deep Learning Frameworks in Python

- TensorFlow 2.x (with keras API)
- PyTorch (dynamic computation graphs)
- Optional: JAX, MXNet

### Lesson 4. Building Neural Networks

- Feedforward Neural Networks (FNNs)
- Multilayer Perception (MLP)
- Model Creation, training and Evaluation

### Lesson 5. Model Training Essentials

- Train/Validation/Test Splits
- Overfitting and Underfitting: Solutions: dropout, regularization, data augmentation
- Batch Normalization
- Learning Rate Schedules: Step decay, Exponential Decay, Cyclic Learning rates
- Early Stopping

## **Lesson 6. Advanced Architectures**

- Convolutional Neural Networks (CNNs)
  - Kernels, Strides, Padding, Pooling
  - Applications: image classification, object detection
- Recurrent Neural Networks (RNNs)
  - Vanilla RNNs, LSTM, GRU
  - Applications: time series, language modelling
- Transformers
  - Attention Mechanism
  - Encoder-Decoder Structure
  - BERT, GPT models overview
- Autoencoders: Denoising, variational autoencoders
- Generative Adversarial Networks (GANs): Generator and Discriminator Networks

## **Lesson 7. Transfer Learning**

- Using pre-trained models (ResNet, VGG, EfficientNet, Bert)
- Fine Tuning vs feature extraction

## **Lesson 8. Practical Applications**

- Computer Vision: Image Classification, Segmentation and Object Detection
- Natural Language Processing (NLP): Text Classification, Machine Translation and Summarization
- Time Series Forecasting: Using RNNs, LSTMs, Temporal Convolutional Networks
- Recommendation Systems