

Deep Learning Course

Picsart Academy

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- 4 Linear and Logistic Regressions as NNs
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Session 1

Deep Learning

What is Deep Learning?

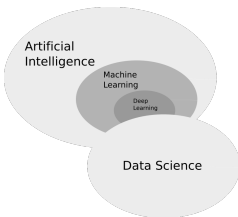


Figure 1: Where does Deep Learning stand in AI?

"Deep learning is a specific subfield of machine learning: a new take on learning representations from data that puts an emphasis on learning successive layers of increasingly meaningful representations. The "deep" in "deep learning" isn't a reference to any kind of deeper understanding achieved by the approach; rather, it stands for this idea of successive layers of representations."

François Chollet in Deep Learning with Python, Second Edition

Frameworks

What is **Deep Learning Framework**?

"Deep learning (DL) frameworks offer building blocks for designing, training, and validating deep neural networks through a high-level programming interface."

Nvidia

Most popular:

- **PyTorch** ← gaining momentum
- **TensorFlow** and **Keras**
- **MXNet**
- **JAX** ← gaining momentum

Introduction: Recommended Material

- Chapter 1, [Deep Learning with Python, Second Edition](#) by François Chollet
- Chapter 1, [Dive into Deep Learning](#) by Zhang A. et al.
- YouTube: [INTRODUCTION TO PYTORCH](#)
- Chapter 1, [Neural Networks and Deep Learning](#) by Michael Nielsen
- Introduction, [Deep Learning](#) by Yoshua Bengio, Ian Goodfellow and Aaron Courville
- GitHub: [Awesome Deep Learning](#)
- Chapter 1, [Deep Learning with PyTorch: A practical approach to building neural network models using PyTorch](#) by Vishnu Subramanian
- Chapter 1, [Deep Learning with PyTorch: Build, Train, and Tune Neural Networks Using Python Tools](#) by Eli Stevens, Luca Antiga, Thomas Viehmann

What is PyTorch?



"An open source machine learning framework that accelerates the path from research prototyping to production deployment"

[PyTorch Webpage](#)

- Tensors
- Datasets, Dataloaders and Transforms
- Autograd
- Vectorisation
- Computational Graph

PyTorch Ecosystem Tools

- Python API
- Ecosystem Tools
 - [Lightning](#): Simplified PyTorch for Research
 - [pyro](#) and [numpyro](#): Deep Universal Probabilistic Programming
 - [BoTorch](#): Bayesian Optimization in PyTorch
 - [fastai](#): fastai simplifies training fast and accurate neural nets using modern best practices
 - [ONNX Runtime](#): Cross-platform inference and training machine-learning accelerator
 - [Transformers](#) by HuggingFace
 - [Ray](#): A unified framework for scaling AI and Python applications
 - [PyTorch NLP](#): NLP library in Python
 - [detectron2](#): State-of-the-art object detection and segmentation algorithms
 - [Optuna](#): Hyperparameter optimization framework

PyTorch Ecosystem Libraries



- [torchaudio](#): audio and signal processing
- [torchvision](#): popular datasets, model architectures, and common image transformations for computer vision
- [torchtext](#): data processing utilities and popular datasets for NLP
- [torchserve](#): model serving

Introduction to PyTorch, tensors, and operations

What is [Tensor](#)?

"A PyTorch Tensor is basically the same as a numpy array: it does not know anything about deep learning or computational graphs or gradients, and is just a generic n-dimensional array to be used for arbitrary numeric computation."

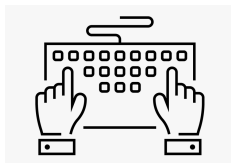
Source: [PYTORCH: TENSORS](#)

Torch tensor:

- Runs on either CPU or GPU
 - For GPU, cast tensor to a [cuda](#) datatype
 - More info on [cuda python](#) and [accelerated computing](#)
- Optimised for automatic differentiation; `grad_fn` property references the backward propagation function

Get used to [numpy library](#) and [numpy array](#) before moving on!

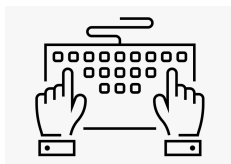
Session 2



Tensors and Operations

GitHub: [tensors](#)

Session 3



Autograd and Vectorisation

GitHub

- [autograd](#)
- [vectorisation](#)

Session 4 and 5

Linear and Logistic Regressions as Neural Nets

Steps to build a Neural Net:

- Model
- Loss function
- Optimiser
- Training

Hyperparameters for training:

- **Number of Epochs** - the number times to iterate over the dataset
- **Batch Size** - the number of data samples propagated through the network before the parameters are updated
- **Learning Rate** - how much to update models parameters at each batch/epoch ([SGD for Linear Regression at MLU](#))

Implementations:

- [Linear Regression](#)
- [Logistic Regression](#)

Neural Networks: Recommended Reading

- Chapter 5 in [Deep Learning with PyTorch](#) by Eli Stevens et al.

Session 6

Deep Neural Networks

What is *deep* in Deep Neural Network?

Let's recall that "the *deep* in 'deep learning' isn't a reference to any kind of deeper understanding achieved by the approach; rather, it stands for this idea of successive layers of representations."

François Chollet in Deep Learning with Python, Second Edition

Ingredients of common deep NN:

- Hidden Layers
- Activation Functions
 - Sigmoid
 - ReLU
 - Tanh

Session 7



Deep Neural Networks

- GitHub: [Multiclass Classification](#)
- Mathematics of Deep Neural Networks
- [Element-wise Activation Functions](#)
- [Row-wise Activation Functions](#)
- [Normalization Layers](#)
- [Dropout Layers](#)

Homework 1

Build a simple neural network using PyTorch to classify **MNIST** digits

Session 8

Convolutional Neural Network (CNN)

What is a convolution?

- Translation Invariance
- Locality
- Convolution Kernel (Filter) and Cross-Correlation Operation
- Edge Detector
- Padding and Strided Convolutions



Figure 2: Where is Waldo?

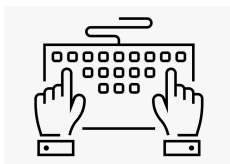
Session 9

Channels in CNN

What is a **channel**?

- Colour image input data might be a 3-dimensional tensor representing an image with *height*, *width*, and *colour*. The amount of red, green, and blue present is represented by the RGB colour channels that's why the image has a shape $3 \times h \times w$
- Filters are applied to each channel separately
- Filters are designed to learn different features in the image
- Resulting outputs are combined to form the output of the convolutional layer
- Channels of an image are typically processed in parallel by different filters
- Multiple Input Channels
- Multiple Output Channels

Session 10



CNN

- [torchvision](#)
 - [Datasets](#)
- [Open-CV](#)
- [MNIST](#)
- [GitHub](#)

Session 11

Advances in Deep Learning & Big CNN Models

- 1995: LeNet
- Advances in GPU
 - GPU is good massively parallel processing for repeatable, identical computations
 - CPU is good for processing multiple, more complex computations at the same time
- **2012:** AlexNet
- 2013: NiN
- 2014: VGG
- 2014: GoogLeNet
- 2015: Batch Normalization and 2016: Layer Normalization
- 2016: ResNet and 2017: ResNeXt
- 2017: DenseNet
- 2018: neural architecture search (NAS) and 2019: EfficientNets
- 2020: RegNet

Convolutional Neural Networks: Recommended Reading

- Chapter 7, 8 in [Dive into Deep Learning](#) by Zhang Aston et al.
- Chapter 7, and 8 in [Deep Learning with PyTorch](#) by Eli Stevens et al.

Session 12

Recurrent Neural Networks (RNNs): Introduction

What is a **Sequence**?

- Autoregressive Models
- Sequence Models
- Markov Models
 - Conditional Probability
- Time Series
- Language Models

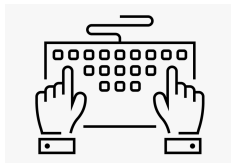
RNNs: Recommended Reading

- Chapter 13 (up to 13.2.1) in [Pattern Recognition and Machine Learning](#) by Christopher Bishop
- Chapter 9 in [Dive into Deep Learning](#) by Zhang Aston et al.

Session 13

RNN: Implementations

- PyTorch's [RNN module](#)
- [Classifying Names with a Character-level RNN](#)



RNN

[GitHub](#)