

# Deep Learning Course

*Picsart Academy*

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# Outline

- 1 Outline
- 2 Deep Learning
- 3 What is PyTorch?
- 4 Linear and Logistic Regressions as NNs
- 5 Deep Neural Networks
- 6 Convolutional Neural Networks
- 7 Recurrent Neural Networks
- 8 Natural Language Processing

# Session 1

# Deep Learning

What is Deep Learning?

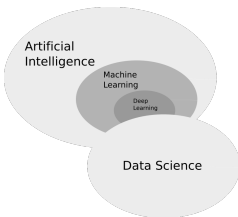


Figure 1: Where does Deep Learning stand in AI?

"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."

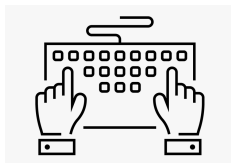
Source: [PYTORCH: TENSORS](#)

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!

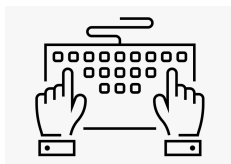
## Session 2



# 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](#)



# Session 6

# Deep Neural Networks

What is *deep* in Deep Neural Network?

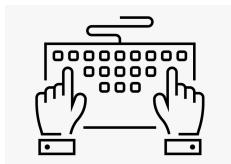
Let's recall that "the *deep* in 'deep learning' isn't a reference to any kind of deeper understanding achieved by the approach; rather, it stands for this idea of successive layers of representations."

*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

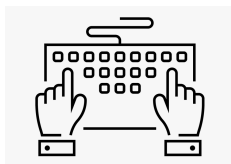


# Channels in CNN

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 5, 7, and 8 in [Deep Learning with PyTorch](#) by Eli Stevens et al.

# Session 12

# Recurrent Neural Networks

What is a **sequence**?

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



# Natural Language Processing

# Introduction to Word Embeddings and Language Modelling

# Sequence labeling and text classification with PyTorch

# Machine translation and generation with PyTorch

## Homework 3

- Use a pre-trained word embedding model to classify sentences
- Use a pre-trained machine translation model to translate a sentence from English to Armenian

# Natural Language Processing: Recommended Reading

- Deep Learning with PyTorch: A practical approach to building neural networks, Chapter 4
- Natural Language Processing with PyTorch, Chapter 2
- Deep Learning with PyTorch, Chapter 5

# Introduction to Word Embeddings and Language Modelling

# Sequence labeling and text classification with PyTorch



# Machine translation and generation with PyTorch

# Homework 4

- Use a pre-trained model to generate text based on a given prompt

# Recurrent Neural Networks: Recommended Reading

- Deep Learning with PyTorch: A practical approach to building neural networks, Chapter 5
- PyTorch for Deep Learning and Computer Vision, Chapter 5
- Hands-On Computer Vision with PyTorch, Chapter 4