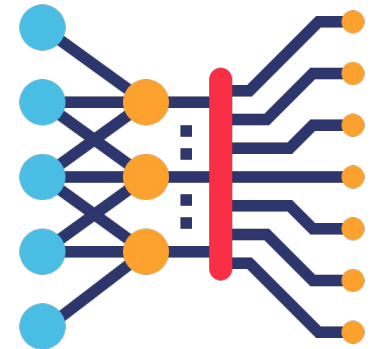


Study of Deep Learning Packages

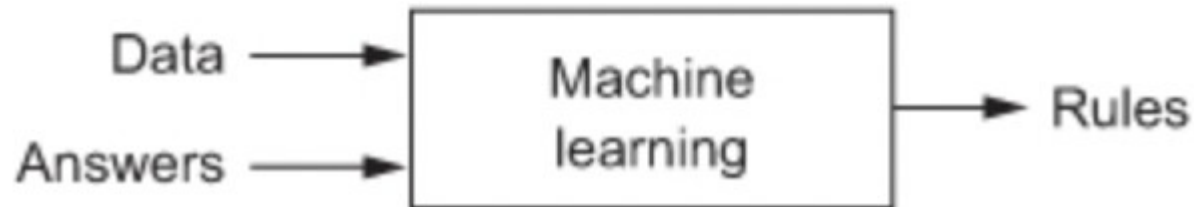
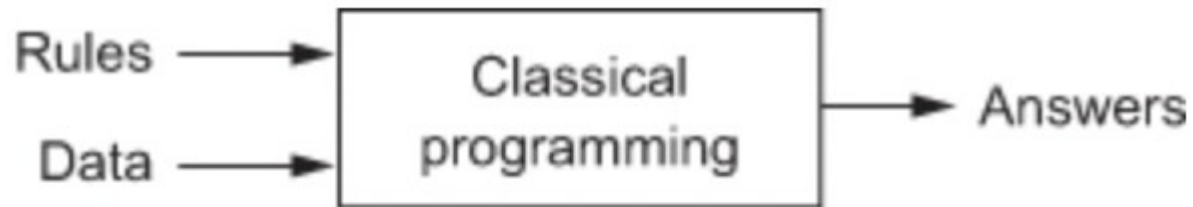
Tushar B. Kute,
<http://tusharkute.com>



What is Deep Learning?

- Deep Learning is a subset of Machine Learning that uses mathematical functions to map the input to the output.
- These functions can extract non-redundant information or patterns from the data, which enables them to form a relationship between the input and the output.
- This is known as learning, and the process of learning is called training.

Programming Patterns

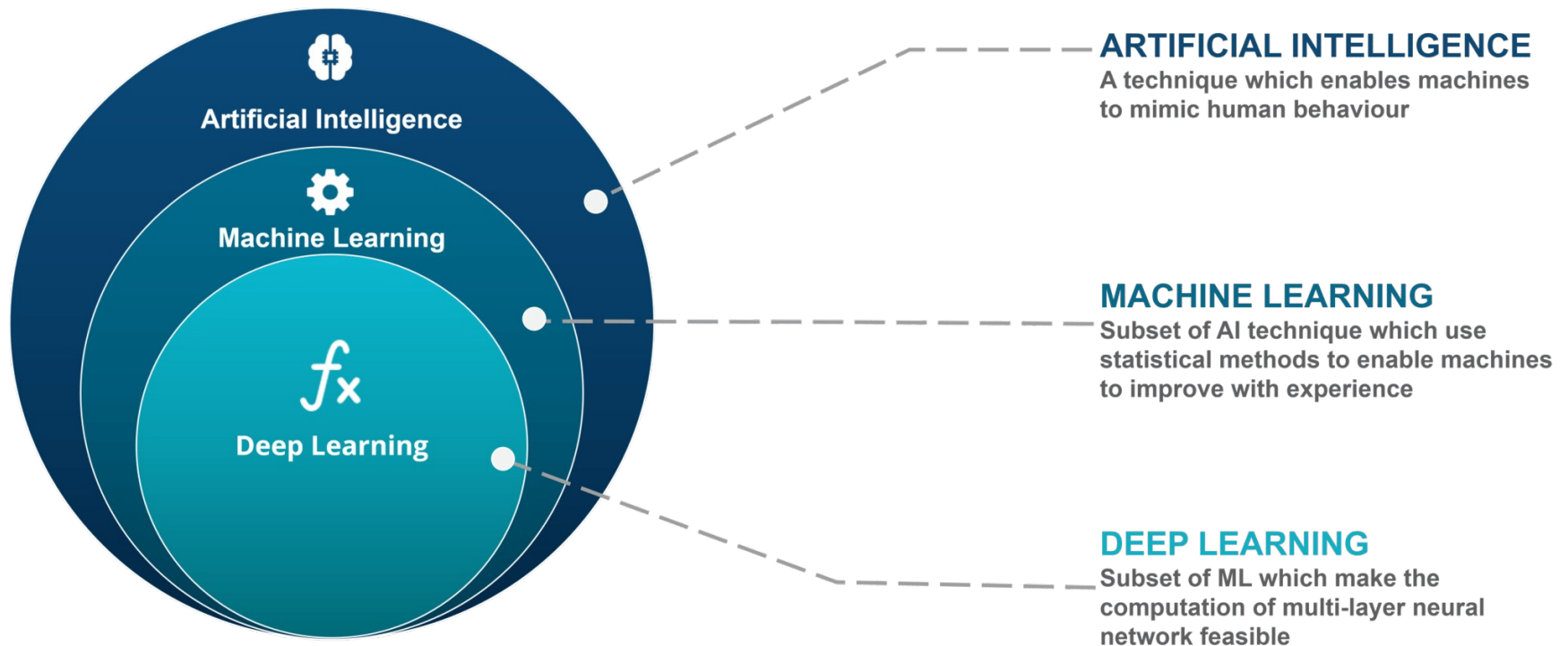


Reference: <https://www.v7labs.com>

Deep Learning

- Modern deep learning models use artificial neural networks or simply neural networks to extract information.
- These neural networks are made up of a simple mathematical function that can be stacked on top of each other and arranged in the form of layers, giving them a sense of depth, hence the term Deep Learning.
- Deep learning can also be thought of as an approach to Artificial Intelligence, a smart combination of hardware and software to solve tasks requiring human intelligence.

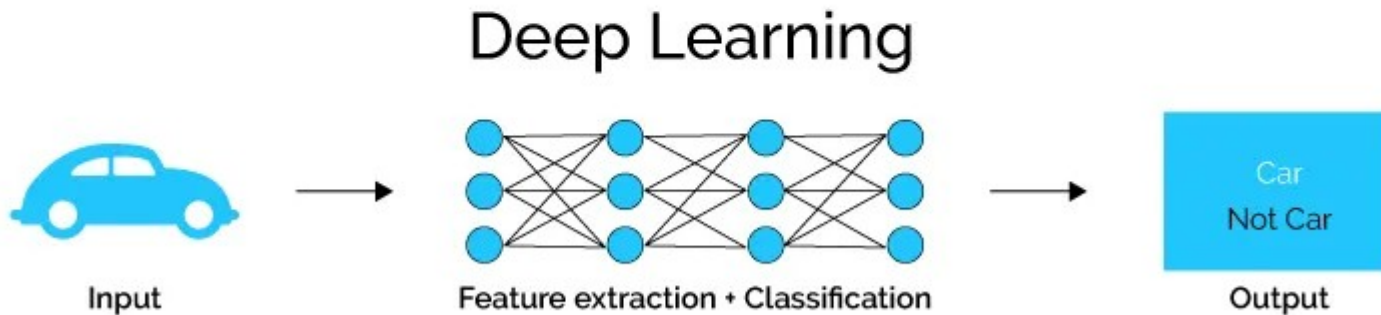
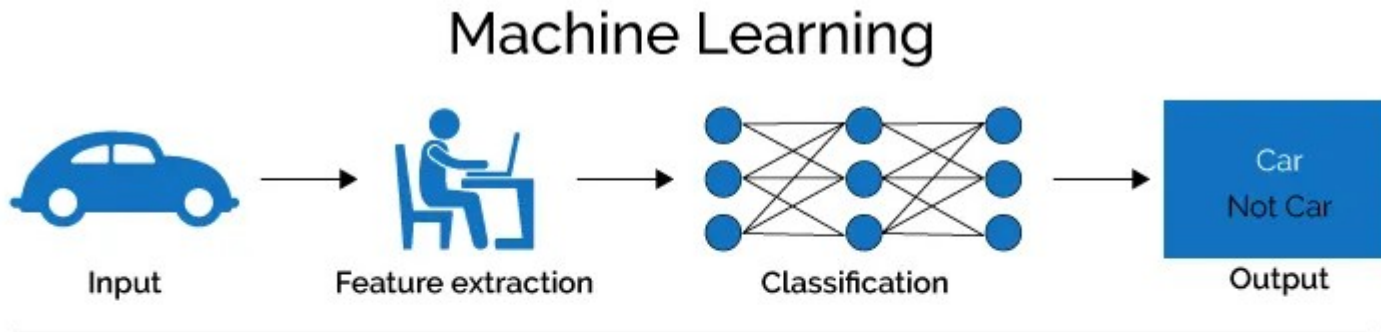
Deep Learning



Deep Learning

- Deep Learning was first theorized in the 1980s, but it has only become useful recently because:
 - It requires large amounts of labeled data
 - It requires significant computational power (high performing GPUs)

Deep Learning vs. Machine Learning



Deep Learning Frameworks

Caffe
(UC Berkeley)



Caffe2
(Facebook)

CNTK
(Microsoft)

Torch
(NYU / Facebook)



PyTorch
(Facebook)

MXNet
(Amazon)

Developed by U Washington, CMU, MIT, Hong Kong U, etc but main framework of choice at AWS

Theano
(U Montreal)



TensorFlow
(Google)

And others...

Top Deep Learning Tools

- Pylearn2 (55 users)
- Theano (50)
- Caffe (29)
- Torch (27)
- Cuda-convnet (17)
- Deeplearning4j (12)
- Other Deep Learning Tools (106)

TensorFlow

- TensorFlow is a very popular open-source library for high performance numerical computation developed by the Google Brain team in Google.
- As the name suggests, Tensorflow is a framework that involves defining and running computations involving tensors.
- It can train and run deep neural networks that can be used to develop several AI applications.
TensorFlow is widely used in the field of deep learning research and application.

Theano and PyLearn2

- Theano and Pylearn2 are both developed at University of Montreal with most developers in the LISA group led by Yoshua Bengio.
- Theano is a Python library, and you can also consider it as a mathematical expression compiler. It is good for making algorithms from scratch.
- If we want to use standard algorithms, we can write Pylearn2 plugins as Theano expressions, and Theano will optimize and stabilize the expressions. It includes all things needed for multilayer perceptron/RBM/Stacked Denoting Autoencoder/ConvNets.

Keras

- Keras is a very popular Machine Learning library for Python.
- It is a high-level neural networks API capable of running on top of TensorFlow, CNTK, or Theano. It can run seamlessly on both CPU and GPU.
- Keras makes it really for ML beginners to build and design a Neural Network.
- One of the best thing about Keras is that it allows for easy and fast prototyping.

- Caffe is developed by the Berkeley Vision and Learning Center, created by Yangqing Jia and led by Evan Shelhamer.
- It is a fast and readable implementation of ConvNets in C++. As shown on its official page, Caffe can process over 60M images per day with a single NVIDIA K40 GPU with AlexNet.
- It can be used like a toolkit for image classification, while not for other deep learning application such as text or speech.

Torch and OverFeat

- Torch is written in Lua, and used at NYU, Facebook AI lab and Google DeepMind. It claims to provide a MATLAB-like environment for machine learning algorithms. Why did they choose Lua/LuaJIT instead of the more popular Python?
- They said in Torch7 paper that “Lua is easily to be integrated with C so within a few hours’ work, any C or C++ library can become a Lua library.” With Lua written in pure ANSI C, it can be easily compiled for arbitrary targets.
- cudnnOverFeat is a feature extractor trained on the ImageNet dataset with Torch7 and also easy to start with.

- There is no doubt that GPU accelerates deep learning researches these days. News about GPU especially Nvidia Cuda is all over the Internet.
- Cuda-convnet/CuDNN supports all the mainstream softwares such as Caffe, Torch and Theano and is very easy to enable.

Compare: Code + Models

| TensorFlow | Theano | Keras | Torch | Caffe |
|--|---|---|--|---|
| <p>More code and models available (hype), including a lot provided by Google, some of open sourced code is already unusable due to very fast development, caffe models loaded in semi-manual way</p> | <ul style="list-style-type: none"> - Lots of code to get started (tutorials and older models). - Loss of momentum and so recent models appear more slowly. - State of the art models can always be found, pretrained models can be slow to appear. - Community based: new code can be unstable. | <p>Models from TensorFlow and Theano + converted model from caffe</p> | <p>State of the art classification models available in the ModelZoo. Significant proportion of research projects in torch.</p> <p>Loadcaffe convert caffe models to torch (often involves 0.5 to 2 days of work when non-sequential architecture or “non-standard layers”)</p> | <ul style="list-style-type: none"> - Extensive code available online (even from the 1st year: >1K forked + significant changes since then) - heaven: state of the art pre-trained models available for a variety of domains - great for fine-tuning networks even without writing code |

Compare: Performance

| TensorFlow | Theano | Keras | Torch | Caffe |
|--|--|--------------------------|--|--|
| Optimized for big models, can be memory hungry, but as fast as others (cuDNN). | <ul style="list-style-type: none"> - Run-time and memory competitive (efficient RNNs), - Compile time can be a huge pain (Strong -). - Multi-GPU support, not multi-machines. | Cf Theano and TensorFlow | <p>All rely on cuDNN.</p> <p>Advantage : no compilation of models, which saves a lot of time during debugging.</p> <p>Memory : some layers are not very efficient because of inner buffers (fixed with OptNet or Pytorch.)</p> | <ul style="list-style-type: none"> - Quite fast, eg. NVIDIA TitanX GPU: <ul style="list-style-type: none"> • Training: ~20 secs/20 iterations (5K images) • Testing: ~70 secs /validation set (50K images) - quick compilation - multi-GPU support but not with python layers - no distributed training |

Compare: Deployment

| TensorFlow | Theano | Keras | Torch | Caffe |
|--|---|--------------------------|--|--|
| TF Serving for self-hosted web, Google Cloud Platform for easy web | Although compiled in C++/CUDA, can't be deployed without Python | Cf Theano and TensorFlow | Require LuaJIT to run models. (Can be problematic for integration more than performance) | + C++ based + stable library - many forks + can be compiled in variety of devices |

Compare: Extra Features

| TensorFlow | Theano | Keras | Torch | Caffe |
|---|------------|--------------------------------|--|--|
| +Written in C++ +Bindings for Python, C++, Java... | +Python | Python | + Written in Lua and C/CUDA | Written in C++ Python and matlab interface |
| +Multi-GPU +Distributed +Windows, Android support | +Multi-GPU | +Multi-GPU +Android support | + multi-GPU + distributed learning (torch-distlearn) + Stability : testing libraries | + allows cross-platform (including windows) + very stable |

Which framework to choose?

- You are a PhD student on DL itself?
- You want to use DL only to get features?
- You work in industry?
- You started your 2 month internship?
- You want to give practise works to your students?
- You are curious about deep learning?
- You don't even know python?

Which framework to choose?

- You are a PhD student on DL itself: **TensorFlow, Theano, Torch**
- You want to use DL only to get features: **Keras, Caffe**
- You work in industry: **TensorFlow, Caffe**
- You started your 2 month internship: **Keras, Caffe**
- You want to give practice works to your students: **Keras, Caffe**
- You are curious about deep learning: **Caffe**
- You don't even know python: **Keras, Torch**

Thank you

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Web Resources

<https://mitu.co.in>
<http://tusharkute.com>

contact@mitu.co.in
tushar@tusharkute.com