

Introduction to Deep Learning

Demystifying Neural Networks



Agenda

Introduction to deep learning:

- What is deep learning?
- Speaking deep learning: network types, development frameworks and network models
- Deep learning development flow
- Application spaces

Deep learning introduction

ARTIFICIAL INTELLIGENCE

Broad area which enables computers to mimic human behavior



MACHINE LEARNING

Usage of statistical tools enables machines to learn from experience (data) – need to be told



DEEP LEARNING

Learn from its own method of computing - its own brain

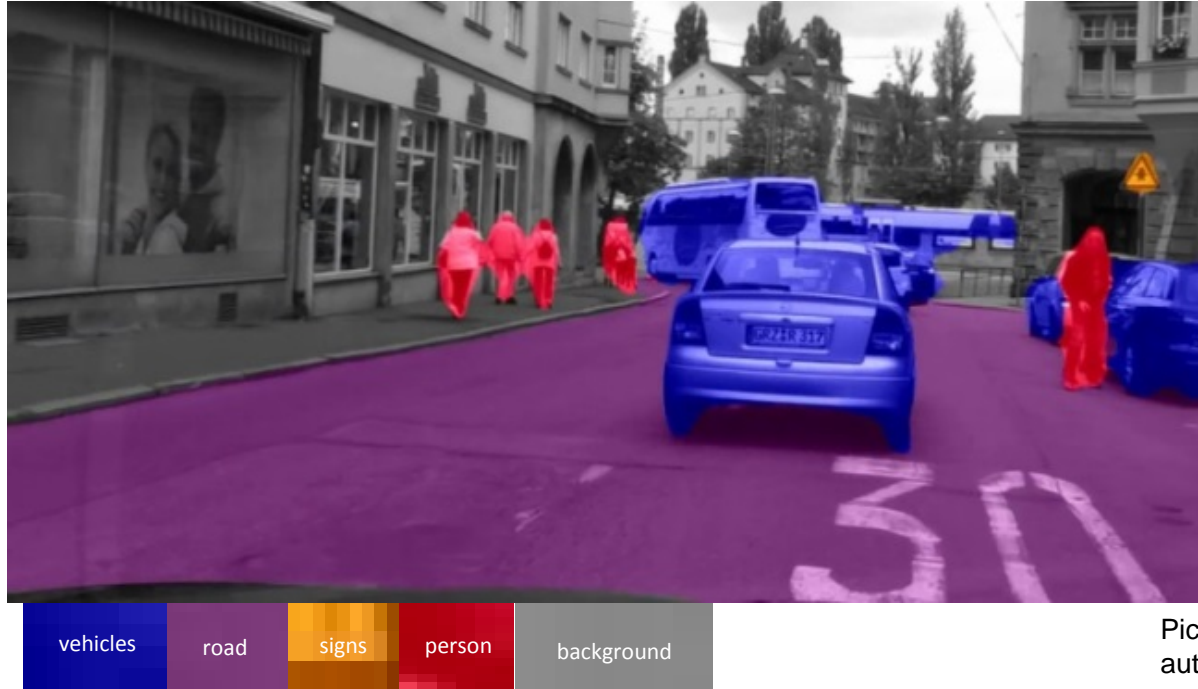
Why is deep learning useful?

Good at classification, clustering and predictive analysis



What is deep learning?

Deep learning is way of classifying, clustering, and predicting things by using a neural network that has been trained on vast amounts of data.

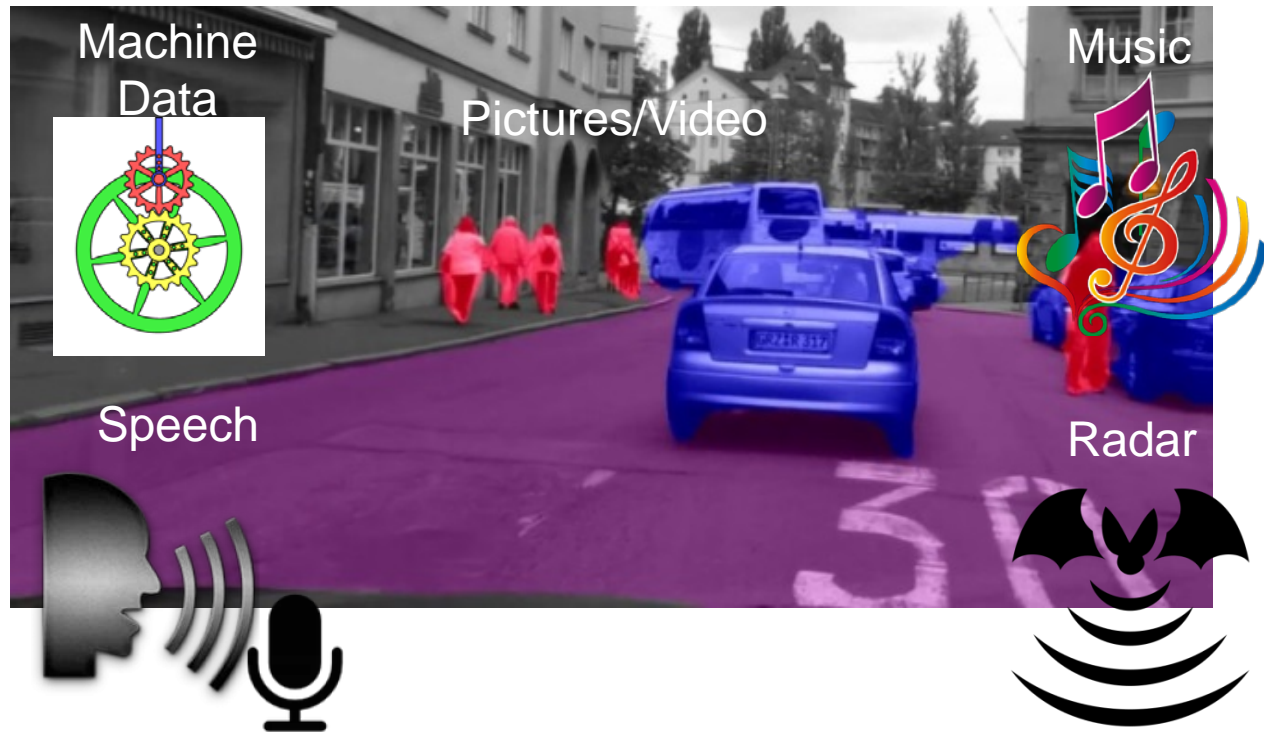


Picture of deep learning demo done by TI's automotive driver assistance systems (ADAS) team.



What is deep learning?

Deep learning is way of classifying, clustering, and predicting things by using a neural network that has been trained on vast amounts of data.



Time of Flight



...any type of data
you want to classify,
cluster or predict

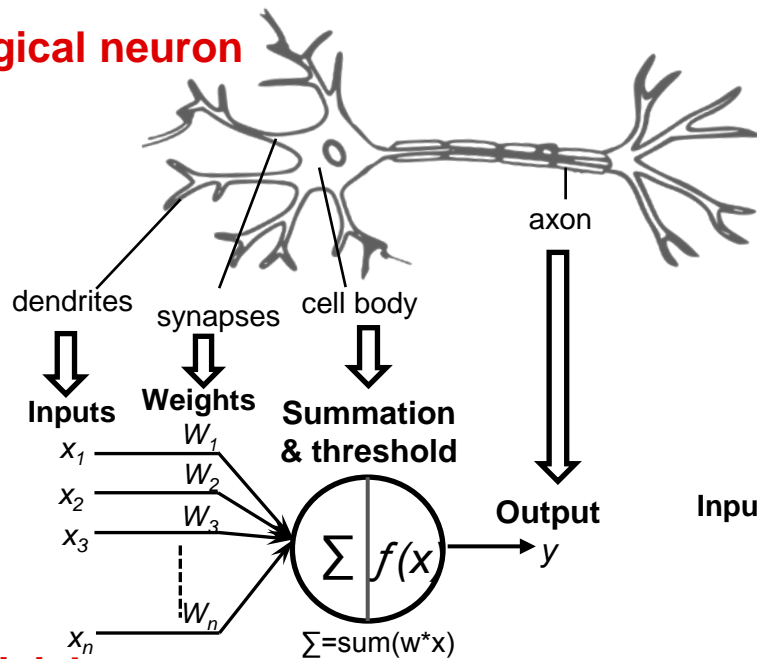




What is deep learning?

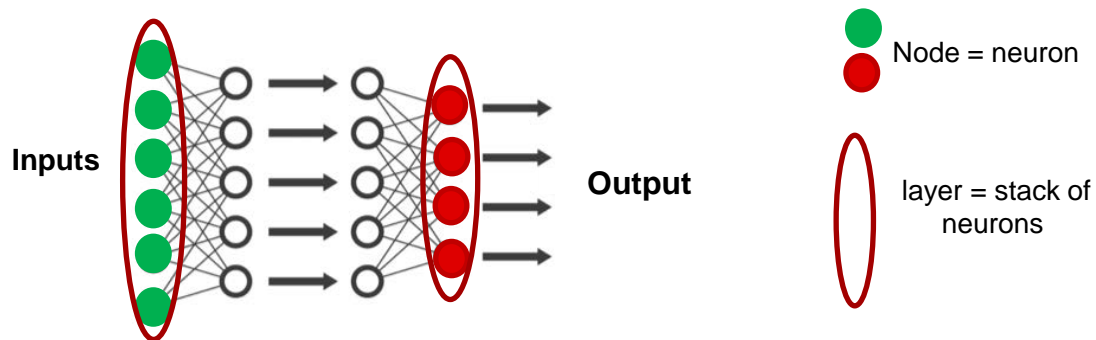
- Deep learning has its roots in neural networks.
- Neural networks are sets of algorithms, modeled loosely after the human brain, that are designed to **recognize patterns**.

Biological neuron



Artificial neuron

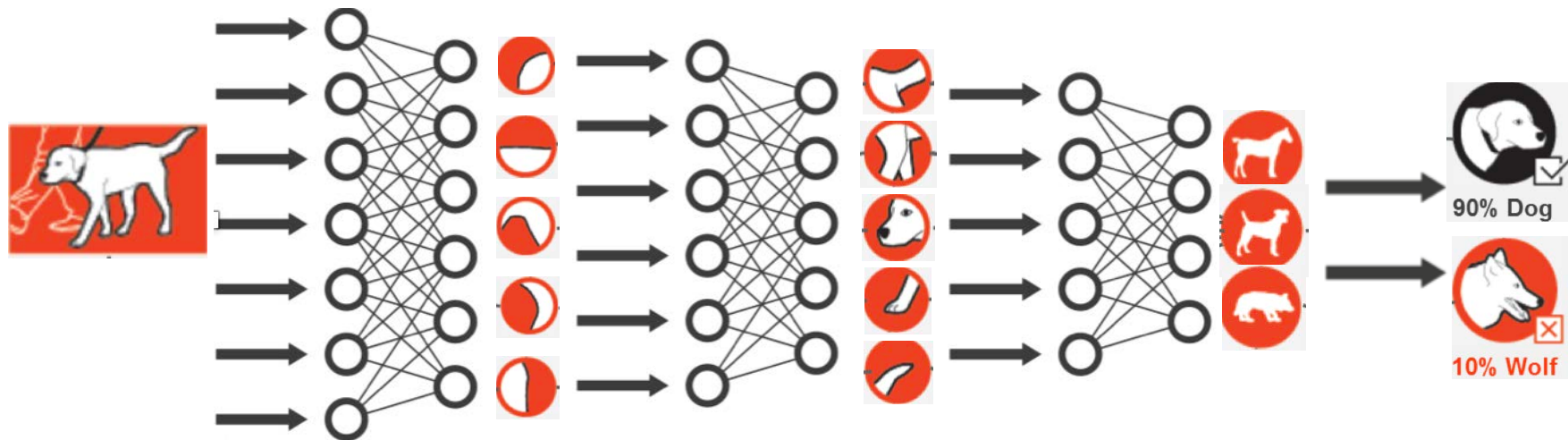
Biological neuron	Artificial neuron
dendrites	inputs
synapses	weight
axon	output
cell body	summation and threshold





What is deep learning?

Deep learning creates many layers of neurons, attempting to learn structured representation of big data, layer by layer.

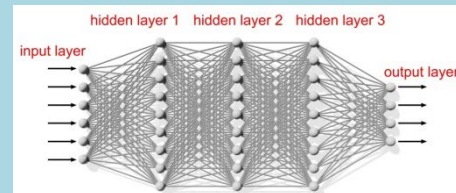




Deep Neural Networks (DNN)

Multi Layer Perceptron (MLP)

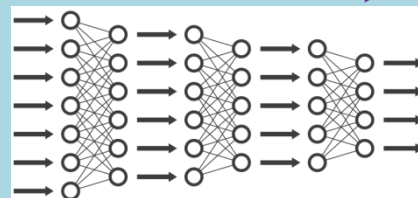
- One of the most traditional types of DL architectures
- Every element of a previous layer, is connected to every element of the next layer. Such layer is called dense layer.
- Fell out of favor, in part because they are hard to train



Convolution Neural Network (CNN)

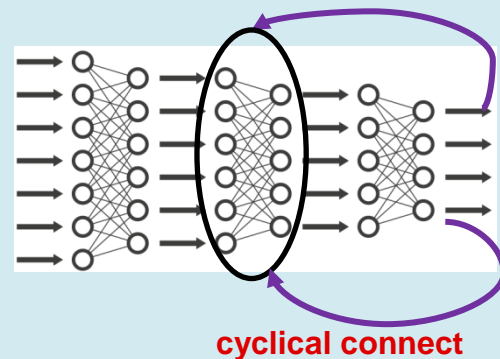
- Type of feedforward deep neural network
- Takes a fixed size inputs and generates fixed-size outputs
- Mostly used in computer vision applications for object detection, classification and semantic segmentation
- Ideal for image and video processing

Feed-forward network



Recurrent Neural Network (RNN)

- Feedforward neural networks extended to include feedback connections
- Use their internal memory to process arbitrary sequence of inputs, hence can handle arbitrary input/output length
- Useful for time series data where features representing the past are assumed to have bearing on the future
- Ideal for text and speech analysis



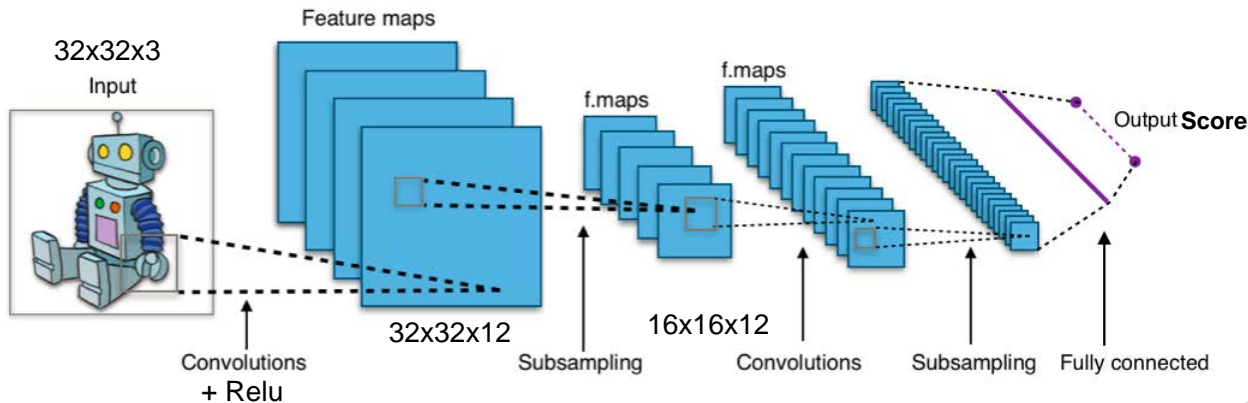


Typical layers involved in CNN

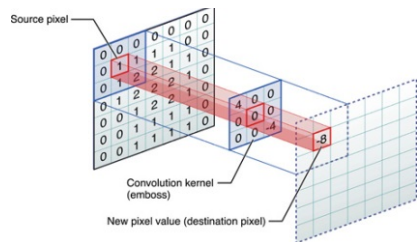
Four filters of size 5x5



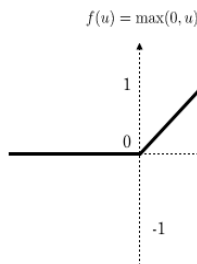
Four filters of size 5x5



Example CNN model

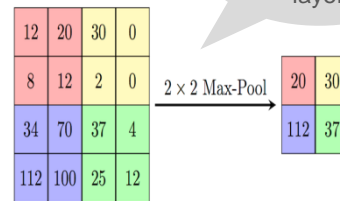


Convolution



ReLu

Determines whether – and to what extent – that signal progresses further through the network



Max pool

Fully-connected layer

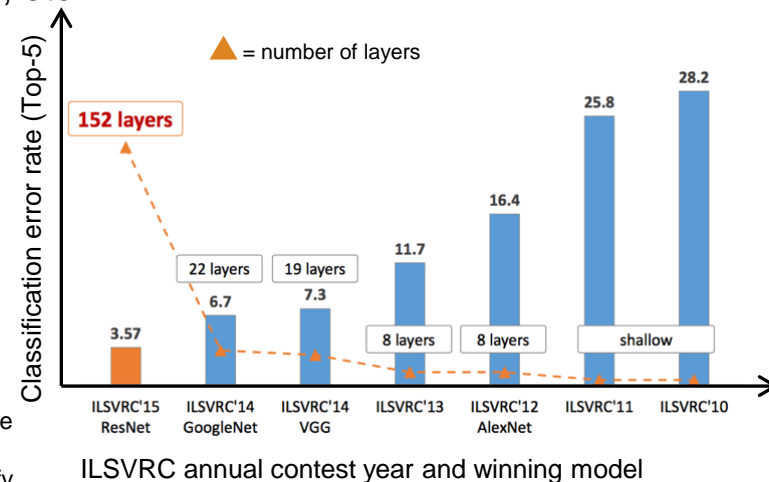
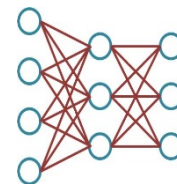


Layers involved



Architecture of the network: Network models

- Deep neural networks are mathematical models of intelligence designed to mimic human brains.
- Network models define a set of network layers and how they interact.
- Questions to answer while designing a network models include:
 - Which layer type to use?
 - How many neurons to use in each layer?
 - How are layers arranged?
 - And more
- There are many standard CNN models available today which work great for many standard problems. Examples being AlexNet, GoogleNet, Inception-ResNet, VGG, etc.



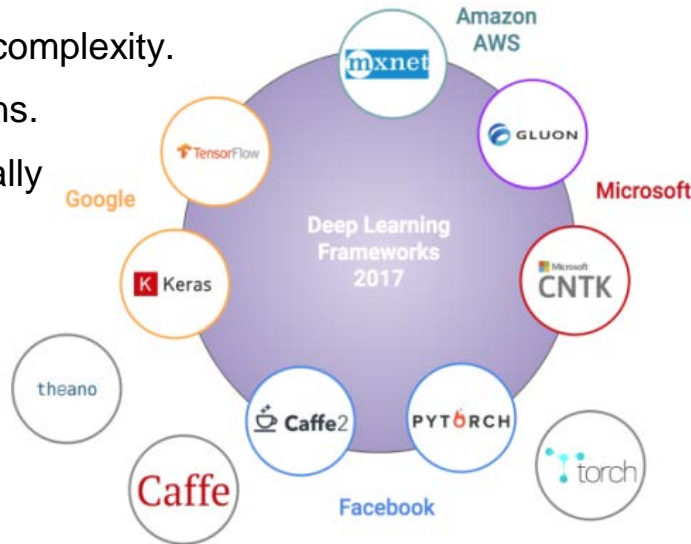
The **ImageNet** project is a large visual database designed for use in visual object recognition software research. Since 2010, the ImageNet project runs an annual software contest – The ImageNet Large Scale Visual Recognition Challenge (ILSVRC), where software programs compete to correctly classify and detect objects and scenes.

Deep learning frameworks

- Building a deep learning solution is a big challenge because of its complexity.
- Frameworks are tools to ease the building of deep learning solutions.
- Frameworks offer a higher level of abstraction and simplify potentially difficult programming tasks.

Popular Frameworks:

- TensorFlow:
 - Developed by Google
 - The most used deep learning framework
 - Based on Github stars and forks and Stack Overflow activity
- Caffe:
 - Developed by Berkeley Vision and Learning Center (BVLC)
 - Popular for CNN modeling (imaging/computer vision applications) and its Model Zoo (a selection of pre-trained networks)

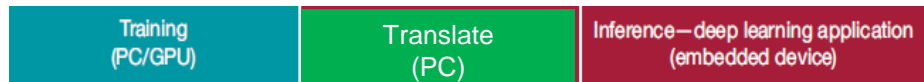
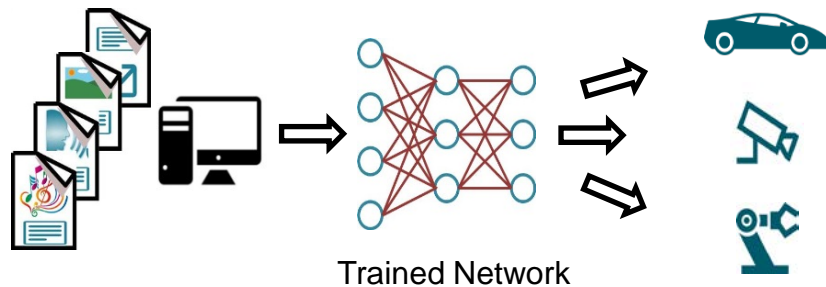


Next to all these frameworks, there are also interfaces that are wrapped around one or multiple frameworks. The most well-known and widely-used interface for deep learning today is Keras. Keras is a high-level deep learning API, written in Python.

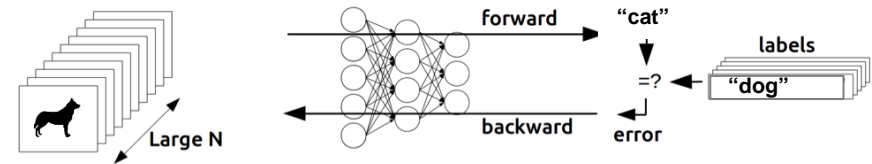


Deep learning development flow

1. Selection of a framework for development
2. Selecting labeled data set of classes to train the network upon
3. Designing initial network model
4. Training the network
5. Saving the parameters and architecture in a binary file
6. Inference

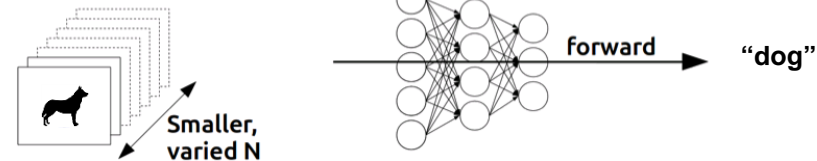


Training



CNN training

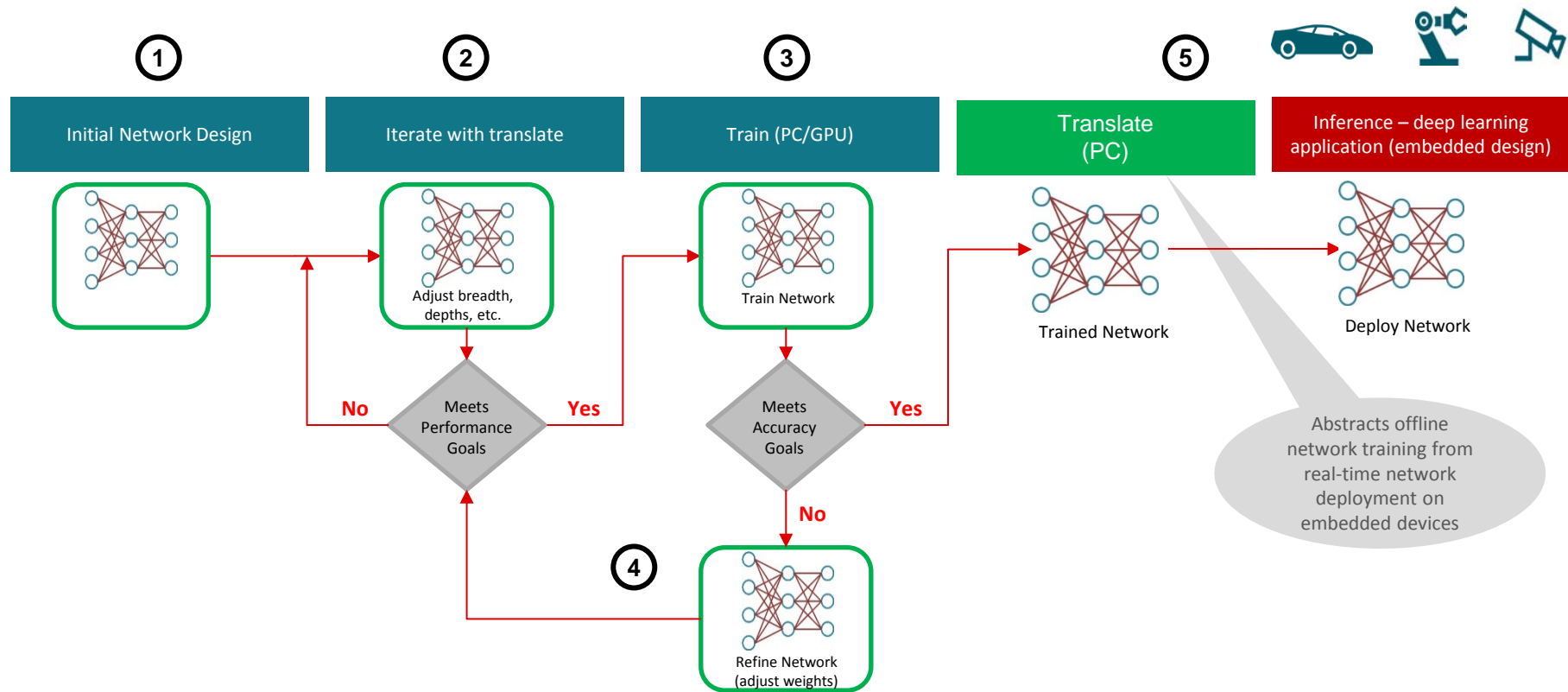
Inference



CNN deployment



Deep learning development flow



Where can deep learning be used?

Anywhere you want to classify data ...

Industrial Factory & Automation



- Improving pick and place
- Predictive maintenance/failure

Agriculture



Optimize crop watering
and harvesting

Retail



- Improve automated checkout
- Track shoppers and provide incentives



Deep learning: A few example uses

Industrial

- Object detection and localization
- Sorting
- Robotics
- Quality control and inspection
- AR (camera pose and location)
- Packaging

Retail

- Analytics
- Warehouse management
- Theft prevention
- Intelligent bar code scanners
- Monitoring and distribution control (shelf replenishment, etc.)

Entertainment/Gaming

- Gesture recognition
- User identification
- Emotional feedback
- Experience monitoring
- Advanced analytics

Smart Homes

- Vacuum cleaners
- Automatic lawn mowers
- Intrusion and Hazard detection
- Smart lights, ovens, refrigerators, etc.

Drones

- Obstacle avoidance
- Path planning
- Flight control with radar and camera sensors

Agriculture

- Autonomous tractors and combines
- Fruit harvesting
- Weed control

Smart Cities & Infrastructure

- Parking
- Traffic monitoring
- Security monitoring
- Road inspection

Food Industry

- Sorting
- Quality control

Mission Critical

- Perimeter surveillance
- Target acquisition
- Fire-and-forget guidance
- Autonomous vehicles



Introduction to deep learning summary

- What is deep learning? Artificial intelligence, or AI, is an umbrella term for any computer program that does something smart. Machine learning is a subset of AI and Deep Learning is subset of Machine Learning.
- Deep learning has its roots in neural networks.
- Neural networks are sets of algorithms, modeled loosely after the human brain, that are designed to recognize patterns.
- Speaking deep learning: Network types, nodes, layers, development frameworks and network models.
- Deep learning solution development flow
- Application spaces



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