Deep Learning
Convolutional Neural Networks
Overview

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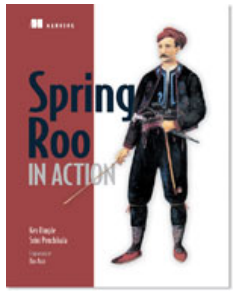
About Me

- Software Architect
- Author of Big Data Processing with Apache Spark book (2017)
- Co-author of "Spring Roo in Action" book (2012)
- Current Focus:
  - Cloud Native Platforms, AI/ML, Microservices/Serverless, Service Mesh



About You

- Role
  - Developers / Architects
  - Data Scientists
  - Data Analysts
  - DBAs, OPS Team
  - Other role?

- Experience in:
  - Deep Learning
  - Tensorflow
  - Docker Containers
  - Python/Java

Scope of Presentation

- What is:
  - CNN overview
  - Sample app to demo how CNN works
- What is not:
  - Detailed discussion on CNN
  - In-Depth CNN talk

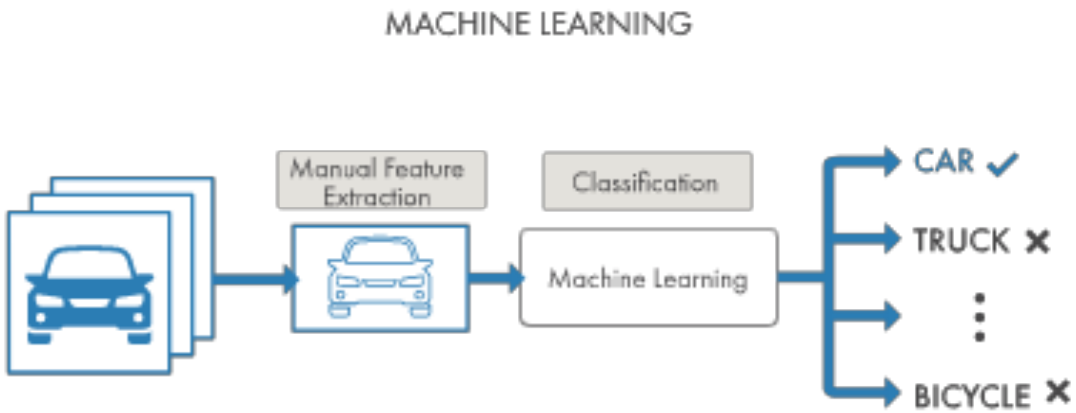
Agenda

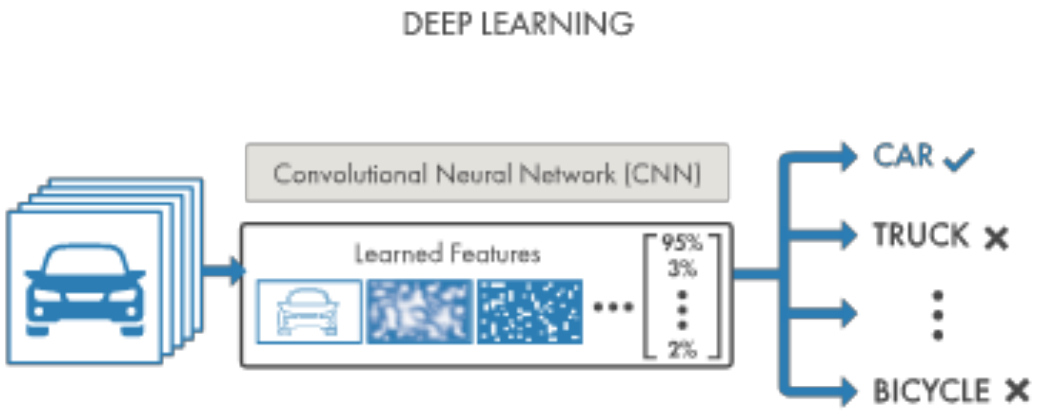
- Deep Learning
- Deep Learning Frameworks
- Convolutional Neural Networks
- Use Cases
- Image Classification
- Tensorflow
- Demos
- Q&A

Deep Learning

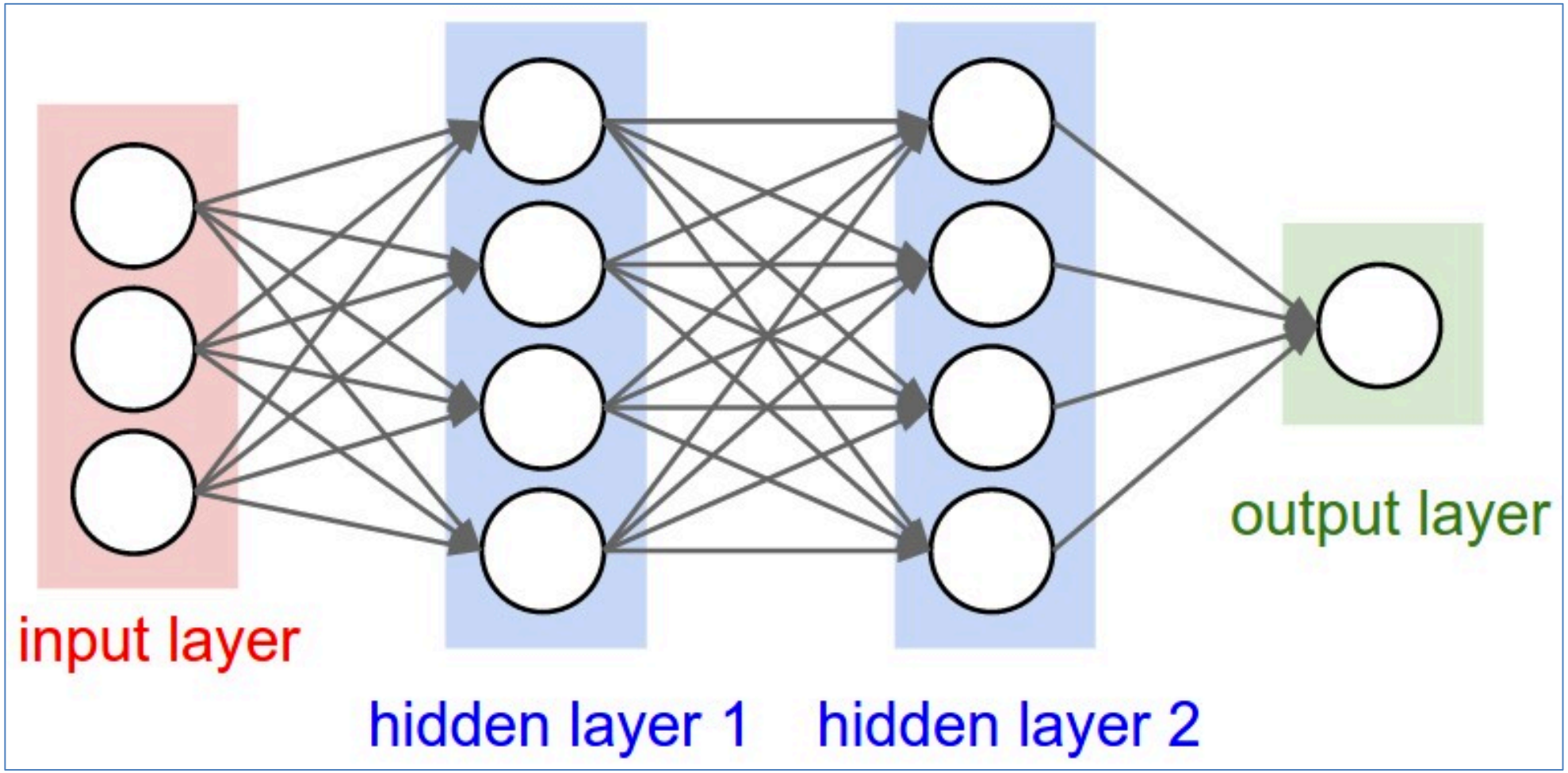
- Also known as deep structured learning or hierarchical learning
- Subset of machine learning
- Algorithms inspired by neural networks & learning data representations as opposed to task-specific algorithms
- Models are trained by using a large set of labeled data and neural network architectures w/ many layers
- Learn features directly from data without the need for manual feature extraction

Deep Learning vs Machine Learning





Deep Learning



Deep Learning Frameworks

- Tensorflow
- Keras
- Microsoft Cognitive Toolkit (CNTK)
- Theano
- Deeplearning4j
- Caffe
- H2O.ai

Convolutional Neural Networks

- Also known as Convnets or CNN

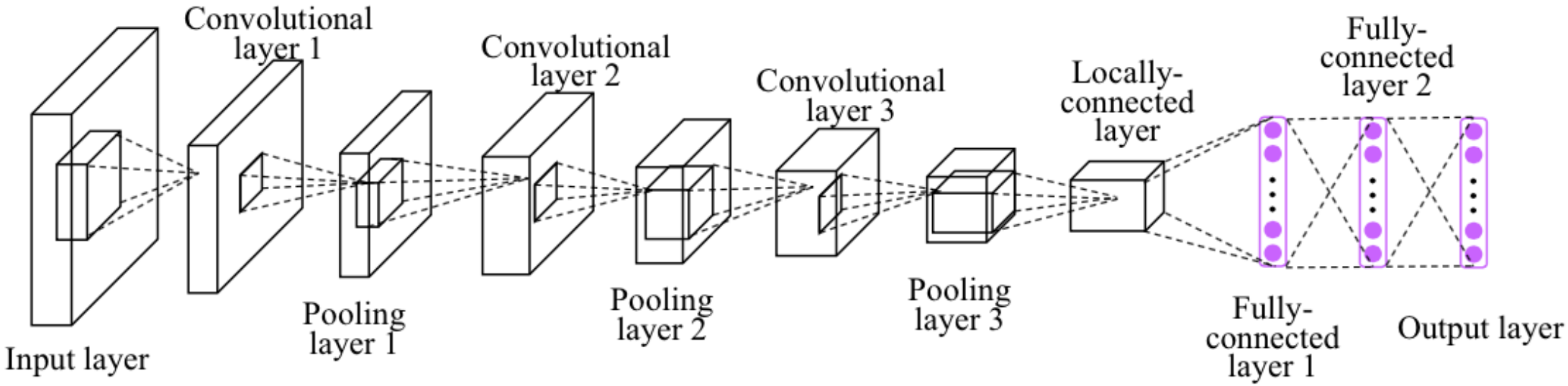
- Apply a series of filters to input data to extract and learn higher-level features, which the model can then use for classification

Components

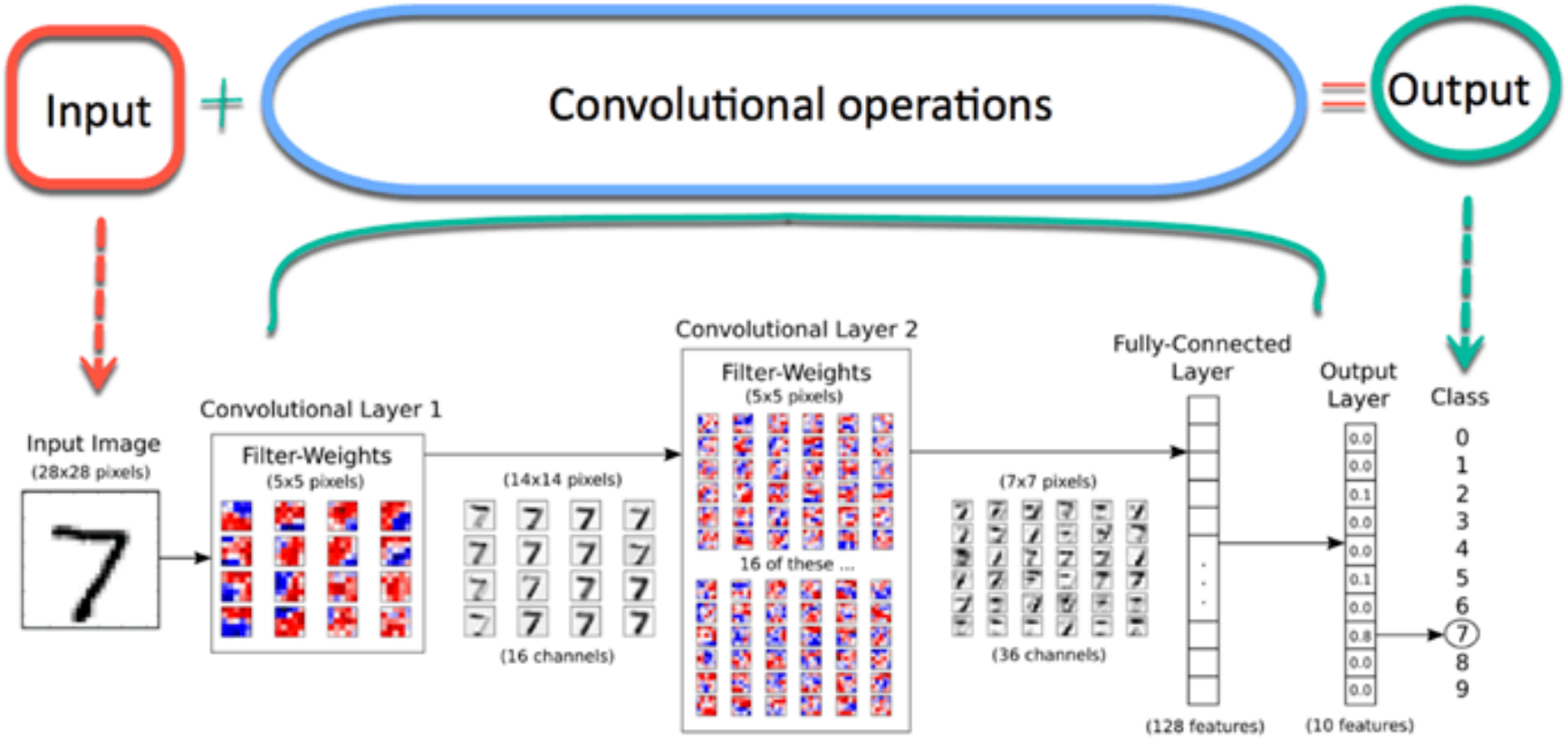
- Input layer
- Convolutional layer
  - Extract features from the input image
  - Apply a specified number of convolution filters to the image
  - Perform a set of operations to produce a single value in output feature map
  - Apply ReLU activation function to output to introduce nonlinearities into the model
- Pooling layer
  - Also called subsampling or downsampling
  - Reduces dimensionality of each feature map but retains the important information
- Dense (fully connected) layer
  - Perform classification on the features extracted by the convolutional layers and downsampled by the pooling layers

TensorFlow Image Classification: CNN (Convolutional Neural Network)

How CNN Works



How CNN Works



Reference: [TensorFlow Image Classification: CNN]

CNN Terminology

- Labeling
  - Process of curating training data
  - Flowers image classification example, images of daisies are dragged into "daisies" folder, roses into "roses" folder, and so on
  - Requires many examples of each type
  - Important and time-consuming process

- Training
  - Feed labeled data (images) to the model
  - Process a random batch of images, use the model to guess what type of flower is in each, test the accuracy of the guesses, and repeat until most of the training data is used
  - Last batch is used to calculate the accuracy of the trained model

- Classification
  - Use the model on new images
  - For example, input: IMG207.JPG, output: daisies
  - Fastest and easiest step and is cheap to scale

CNN Terminology

- Inception model
  - Deep convolutional neural network architecture for classification and detection on the ImageNet dataset
  - We use Inception v3 in our example

- Bottleneck
  - Layer just before the final output layer that actually does the classification
  - Data stored in "/tmp/bottleneck" directory; if we rerun the script they'll be reused so you don't have to wait for this part again
  - Once bottleneck files for all the training data are created, program trains the last layer of Inception

Transfer Learning

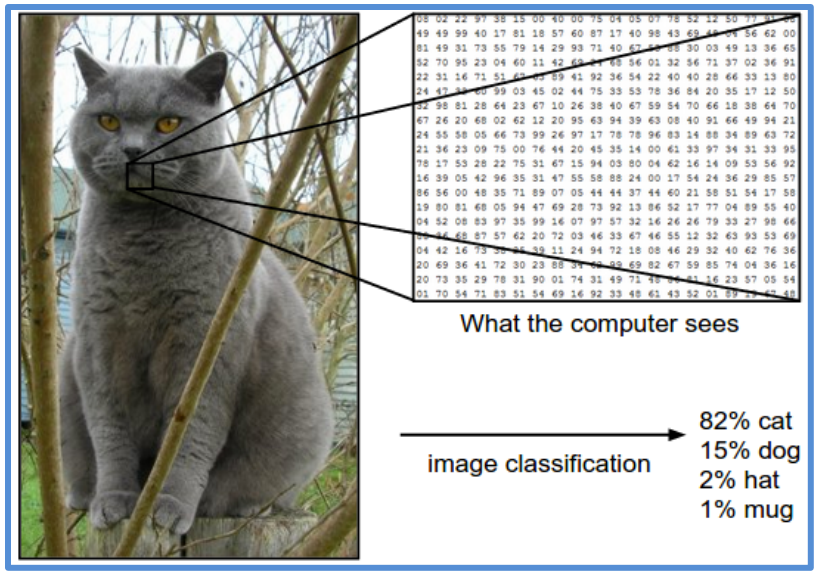
- Make use of knowledge gained while solving one problem and applying it to a different but related problem
- Example: knowledge gained while learning to recognize “cars” can be used to recognize “trucks”
- Use existing data set with fully trained image classification model and retrain the last layers of the model
- No need to train a classifier from scratch
- Leverage to train models with less data

CNN Use Cases

- Image recognition
- Language translation
- Speech recognition
- Video analysis
- Natural language processing
- Health risk assessment
- Autonomous vehicles
- Crowd Counting Use Case

Image Classification

- Task of assigning an input image one label from a fixed set of categories
- Take an array of pixels that represents a single image & assign a label to it
- Take a new image that falls into a category we've trained and run it through a command that will tell us in which category the image fits
- Image classification pipeline
- Input
  - Input consists of a set of N images, each labeled with one of K different classes. We refer to this data as the training set.
- Learning
  - Use the training set to learn what every one of the classes looks like
  - Called "training a classifier"
- Evaluation
  - Evaluate the quality of classifier by asking it to predict labels for a new set of images



Tensorflow

- End-to-end open source platform for ML
- Ecosystem of tools, libraries and community resources
- Developed by Google Brain team for internal use
- Released under Apache License 2.0 on Nov, 2015
- Let researchers push state-of-the-art in ML and developers easily build & deploy ML powered applications
- Tensorflow Tutorials
- Google Colab Jupyter Notebook environment

Deep Learning and Serverless

- Serverless computing
  - cloud-computing model where cloud provider runs the server, and dynamically manages allocation of machine resources

- Frameworks
  - Serverless.com
  - OpenFaaS
  - Azure Functions
  - Google Cloud Functions
  - Knative

- TensorFlow and the Serverless Framework for deep learning and image recognition

- Serverless Deep Learning with TensorFlow and AWS Lambda (UDemy)

Demo 1

- Use case: Image classification

- Technologies and Tools
  - TensorFlow
  - TensorFlow Hub
  - Python
  - Docker

- Sample application references
  - https://www.tensorflow.org/tutorials/images/deep_cnn
  - https://opensource.com/article/17/12/tensorflow-image-classification-part-1
  - Image Classification using Tensorflow (on Docker + Windows)

- Sample Data Set
- Python Scripts
- Pre-trained Inception model

Demo 1 – Steps

- Install Docker
- Install Tensorflow
- Download images dataset
- Launch Tensorflow inside Docker container
- Copy files to container
- Retrain the model*
- Test the model (Make a prediction)

*Long running step (~30 mins for our example)

Demo 2 - Serverless

- Use case: Image recognition

- Technologies and Tools
  - TensorFlow
  - Java
  - Java Function API
  - Serverless framework

- Sample application references
  - https://github.com/ianrufus/BlogPosts/tree/master/ServerlessMiniSeries/1
  - http://emaraic.com/blog/object-recognition-using-TensorFlow-Java

References

- Tensorflow website
- CNN Overview Article
- CNN and Tensorflow tutorial

Thank You

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- Big Data Processing using Apache Spark
- Spring Roo in Action Book

Questions?