

# PATTERN RECOGNITION AND MACHINE LEARNING SYSTEMS DAY 1A

Dr Zhu Fangming  
Institute of Systems Science  
National University of Singapore  
[fangming@nus.edu.sg](mailto:fangming@nus.edu.sg)

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# DAY 1 AGENDA

1.1 Introduction to Pattern Recognition and Machine Learning Systems

1.2 Neural Network Basics

1.3 Neural Network Workshop - Building Multi-Layer Perceptron Neural Networks using Weka and Python

# 1.1

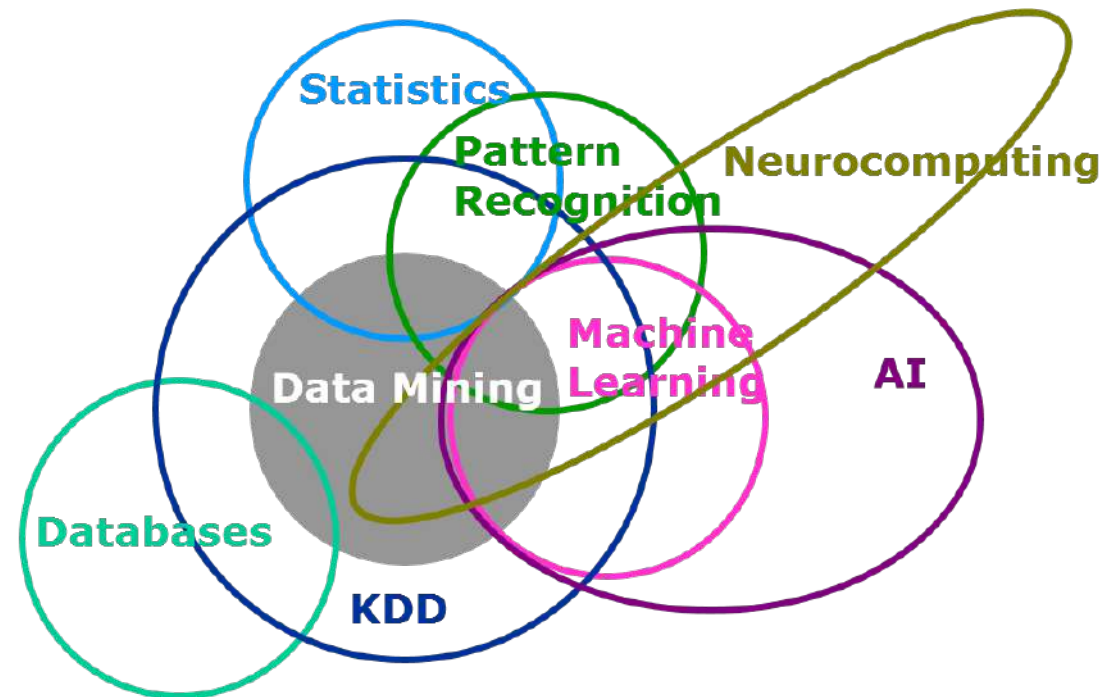
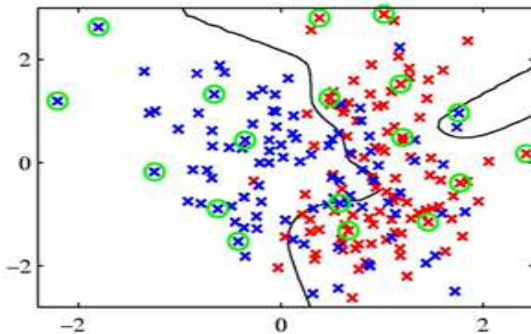
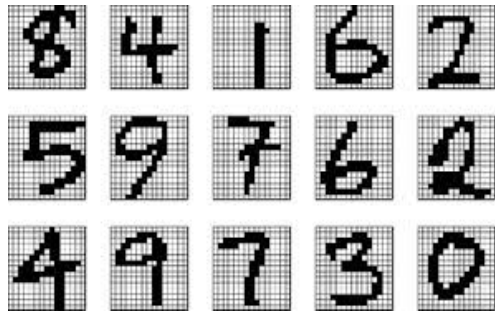
## Introduction to Pattern Recognition and Machine Learning Systems

- **What is Pattern Recognition?**
- **Machine Learning Basics**
- **Deep Learning Basics**
- **Applications of Pattern Recognition and Machine/Deep Learning Systems**

# Pattern Recognition

- Pattern is in everything around us in this digital world.

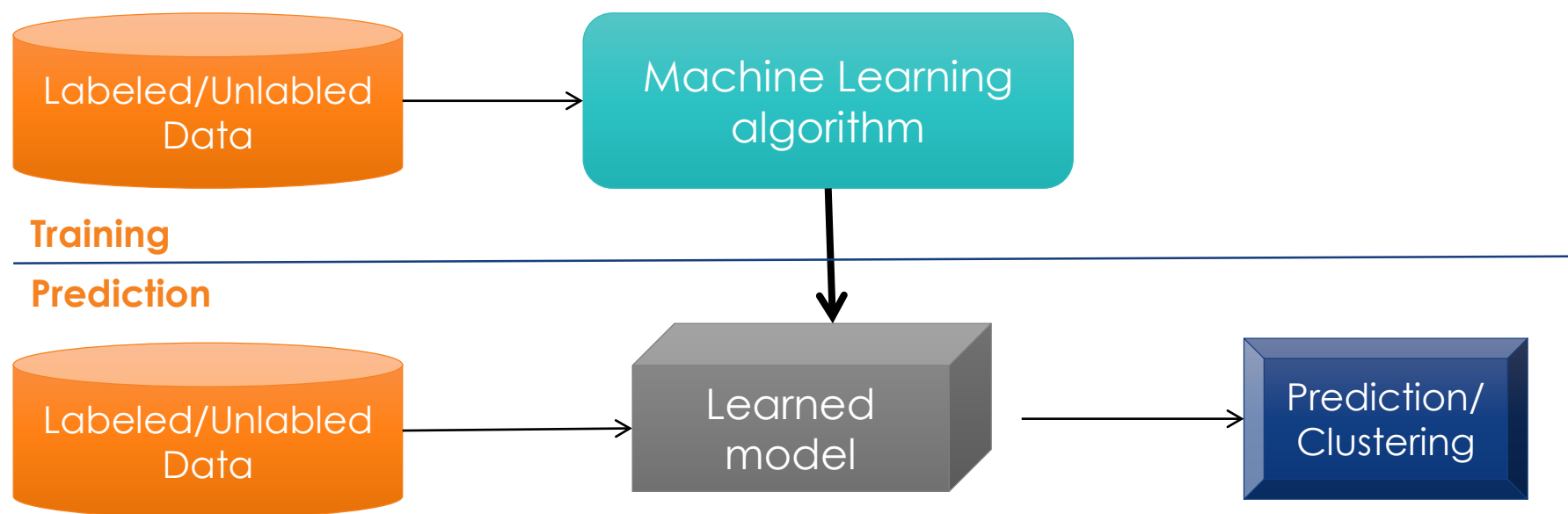
Visual, audio, text, temporal...



<https://www.analyticsvidhya.com>

# Machine Learning Basics

“Pattern Recognition is a type of problem while Machine Learning is a type of solution.”



# Types of Machine Learning

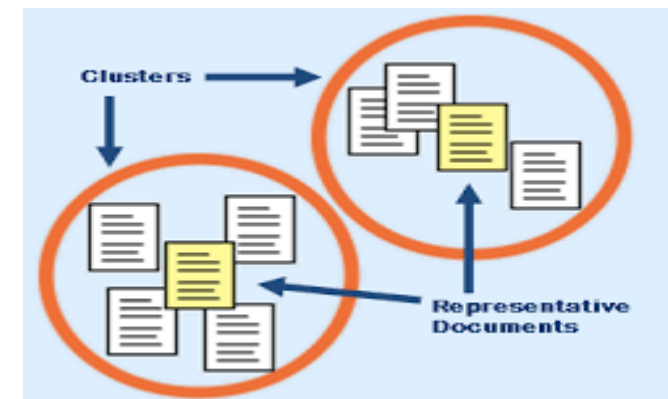
- **Supervised: Learning with a labeled training set**

eg: Spam email classification - classify emails as legitimate or spam.



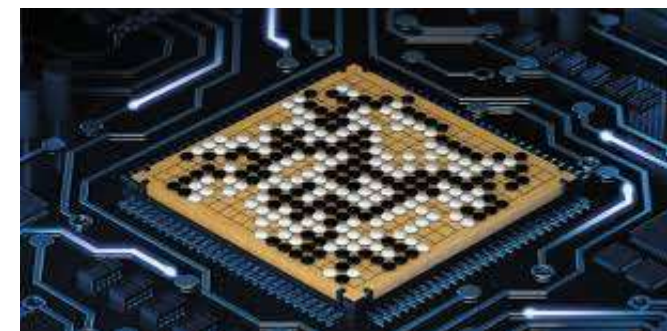
- **Unsupervised: Discover patterns in unlabeled data**

eg: Document clustering- cluster similar documents based on text



- **Reinforcement learning: learn to act based on feedback/reward**

eg: learn to play Go, reward: win or lose



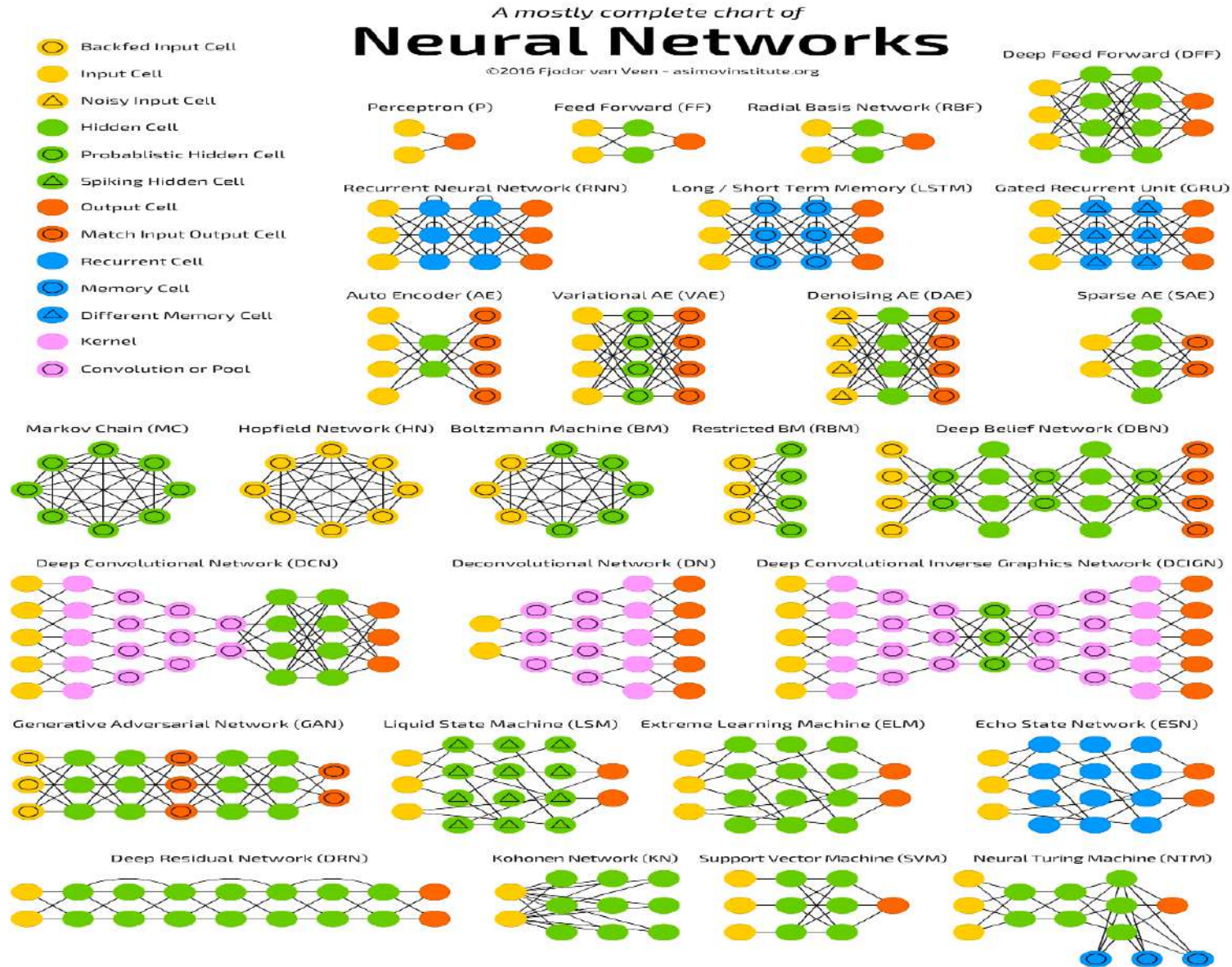
# Machine Learning Techniques

- Regression Algorithms (eg. Linear Regression, Logistic Regression)
- Instance-based Algorithms (eg. k-Nearest Neighbor (kNN))
- Decision Tree Algorithms
- Bayesian Algorithms
- Clustering Algorithms
- Association Rule Learning Algorithms
- Artificial Neural Network Algorithms
- Deep Learning Algorithms
- Dimensionality Reduction Algorithms
- Ensemble Algorithms
- .....

Source: <https://machinelearningmastery.com/>

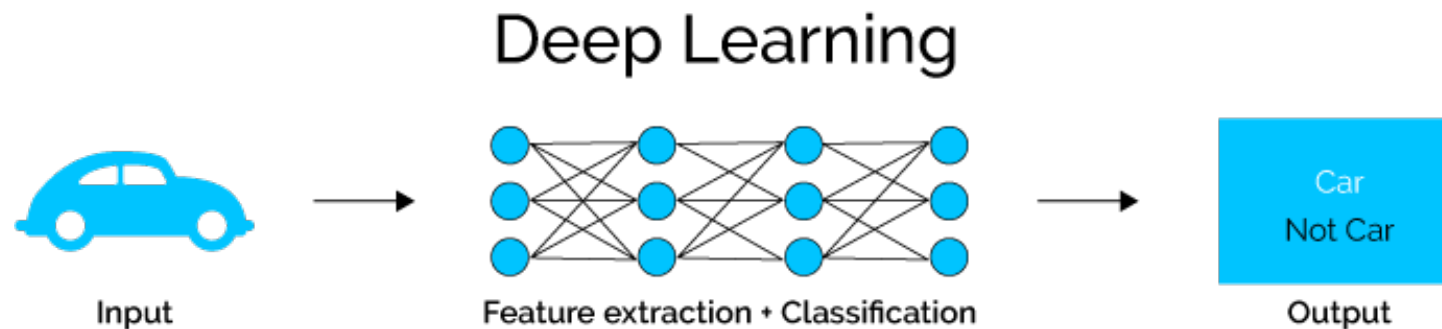
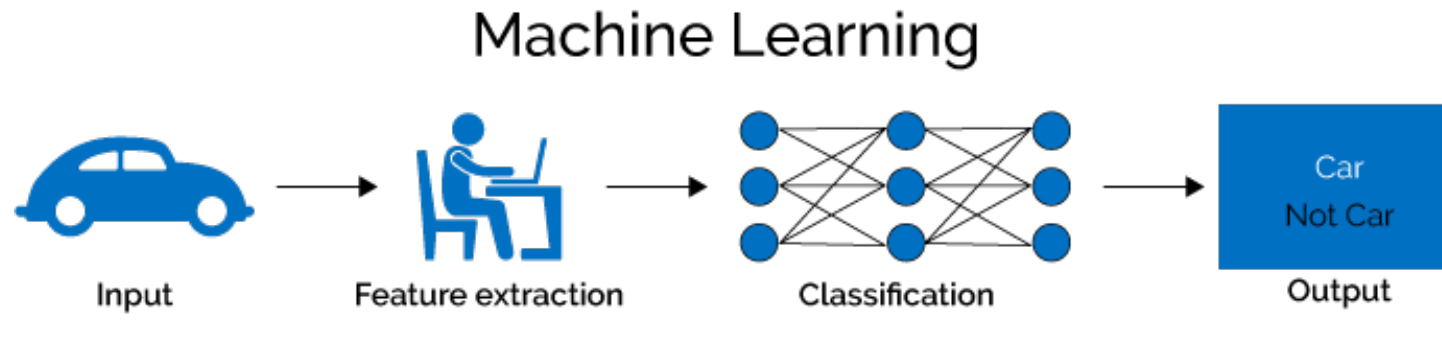


# Neural Networks



# Deep Learning (DL)

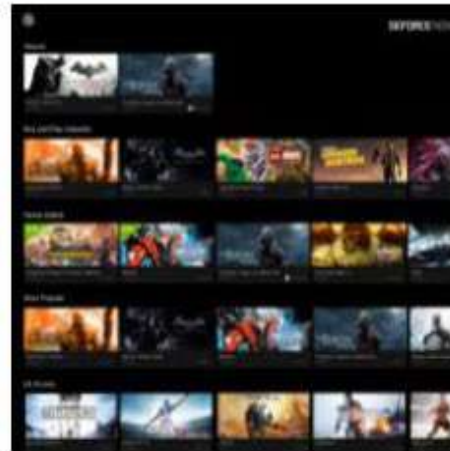
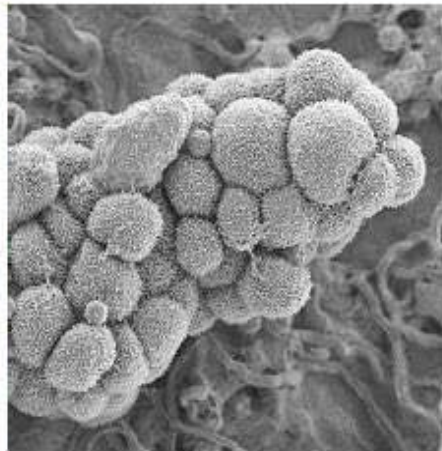
- A machine learning subfield of learning representations of data. Exceptional effective at learning patterns.
- Deep learning algorithms attempt to learn (multiple levels of) representation by using a hierarchy of multiple layers.



<https://www.xenonstack.com/blog/static/public/uploads/media/machine-learning-vs-deep-learning.png>



## DEEP LEARNING EVERYWHERE



### INTERNET & CLOUD

Image Classification  
Speech Recognition  
Language Translation  
Language Processing  
Sentiment Analysis  
Recommendation

### MEDICINE & BIOLOGY

Cancer Cell Detection  
Diabetic Grading  
Drug Discovery

### MEDIA & ENTERTAINMENT

Video Captioning  
Video Search  
Real Time Translation

### SECURITY & DEFENSE

Face Detection  
Video Surveillance  
Satellite Imagery

### AUTONOMOUS MACHINES

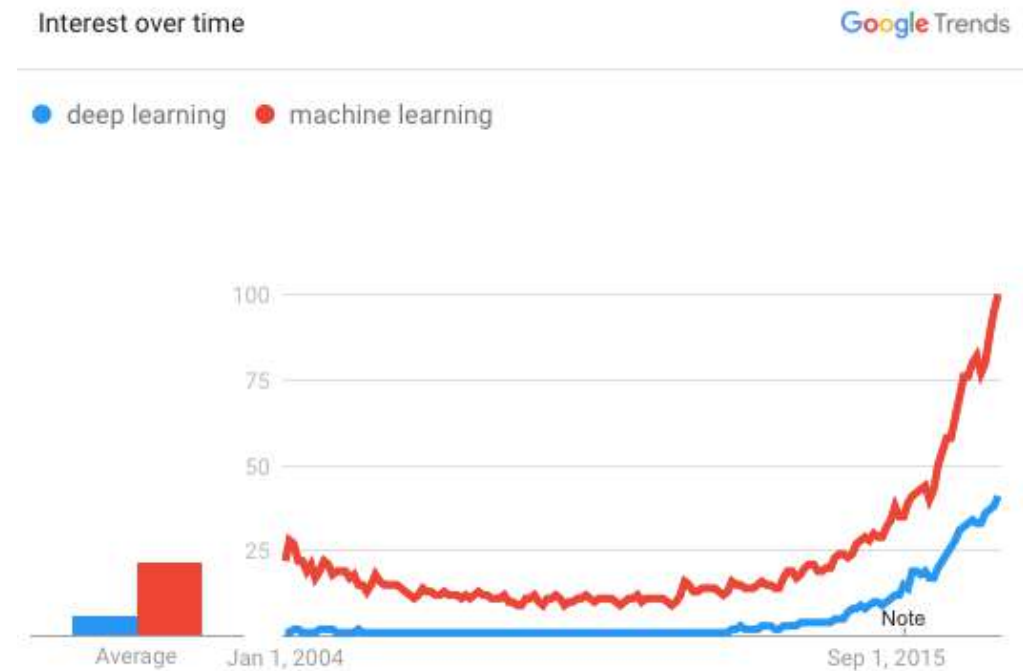
Pedestrian Detection  
Lane Tracking  
Recognize Traffic Sign

source: [developer.nvidia.com/deep-learning-courses](https://developer.nvidia.com/deep-learning-courses)

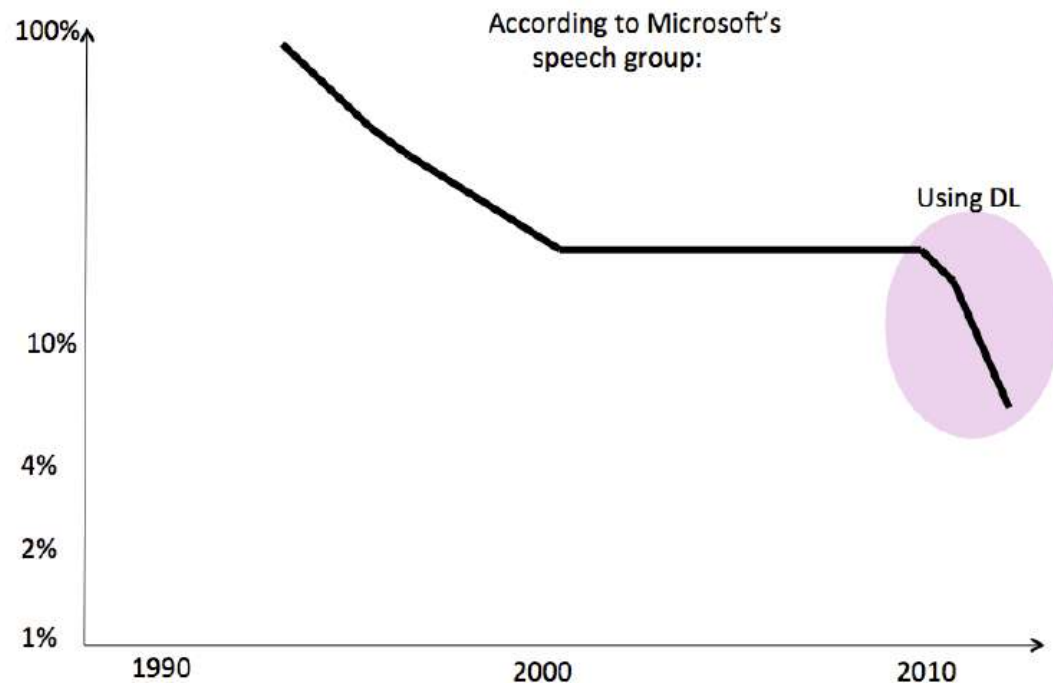
# Deep Learning

- Manually designed features are often over-specified, incomplete and take a long time to design and validate
- Learned Features are easy to adapt, fast to learn
- Deep learning provides a very flexible and learnable framework for representing information
- Can learn both unsupervised and supervised
- Effective end-to-end joint system learning
- Utilize large amounts of training data

In ~2010 DL started outperforming other ML techniques  
first in speech and vision, then NLP



# Deep Learning



Deep Learning in Speech Recognition



ImageNet: The "computer vision World Cup"

Several big improvements in recent years in NLP

- ✓ Machine Translation
- ✓ Sentiment Analysis
- ✓ Dialogue Agents
- ✓ Question Answering
- ✓ Text Classification ...

Leverage different levels of representation

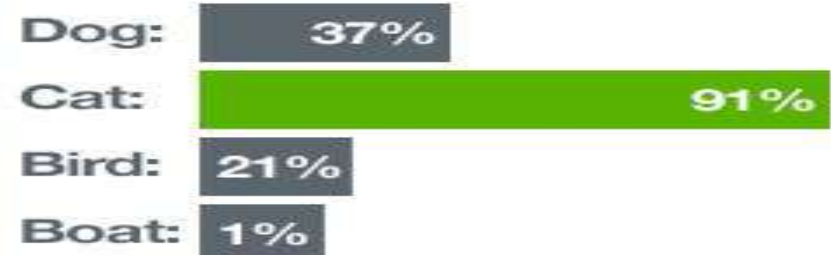
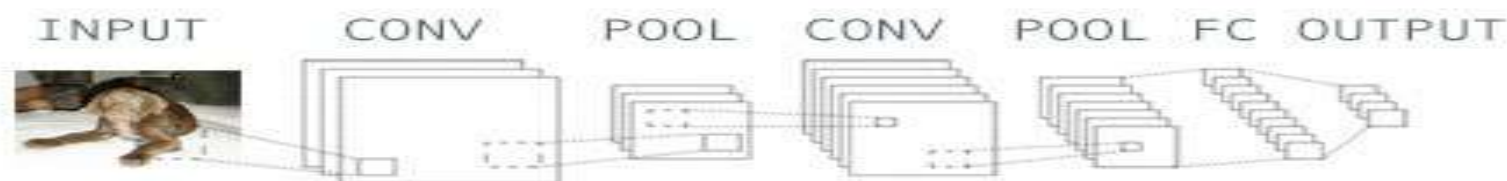
- words & characters
- syntax & semantics

# Applications of Machine Learning / Deep Learning

- Biomedical informatics
- Computer vision
- Customer relationship management
- Data mining
- Email filtering
- Natural language processing (NLP)
- Pattern recognition
  - Facial recognition system
  - Handwriting recognition
  - Image recognition
  - Optical character recognition
  - Speech recognition
- Recommendation system
- .....



# PR and ML Systems: Image Classification



Source: pyimagesearch.com

# PR and ML Systems: Image Classification

## ConvNetJS CIFAR-10 demo

### Description

This demo trains a Convolutional Neural Network on the [CIFAR-10 dataset](#) in your browser, with nothing but Javascript. The state of the art on this dataset is about 90% accuracy and human performance is at about 94% (not perfect as the dataset can be a bit ambiguous). I used [this python script](#) to parse the [original files](#) (python version) into batches of images that can be easily loaded into page DOM with img tags.

This dataset is more difficult and it takes longer to train a network. Data augmentation includes random flipping and random image shifts by up to 2px horizontally and vertically.

By default, in this demo we're using Adadelta which is one of per-parameter adaptive step size methods, so we don't have to worry about changing learning rates or momentum over time. However, I still included the text fields for changing these if you'd like to play around with SGD+Momentum trainer.

Report questions/bugs/suggestions to [@karpathy](#).

### Training Stats

pause

Forward time per example: 11ms  
Backprop time per example: 20ms  
Classification loss: 1.76748  
L2 Weight decay loss: 0.00182  
Training accuracy: 0.38  
Validation accuracy: 0.35  
Examples seen: 3511

Learning rate:

change

Momentum:

change

Batch size:

change

Weight decay:

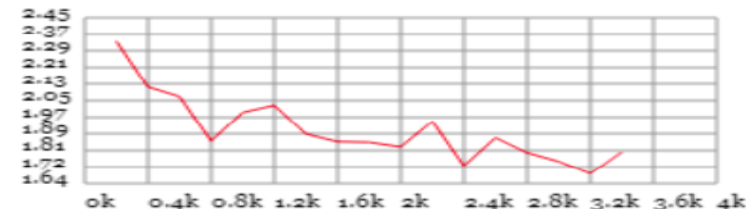
change

save network snapshot as JSON

init network from JSON snapshot

load a pretrained network (achieves ~80% accuracy)

Loss:



clear graph

<https://cs.stanford.edu/people/karpathy/convnetjs/demo/cifar10.html>



# PR and ML Systems: Object Detection



## Objects Detection Machine Learning TensorFlow Demo

Amphan Libraries & Demo

★★★★★ 247

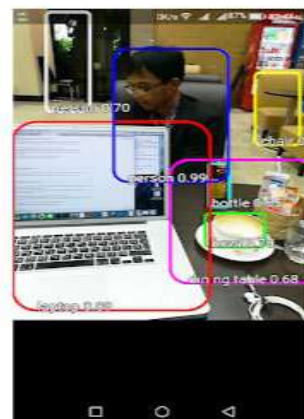
3+

Contains ads

This app is compatible with all of your devices.

Add to wishlist

Install



Objects Detection Machine Learning TensorFlow Demo.

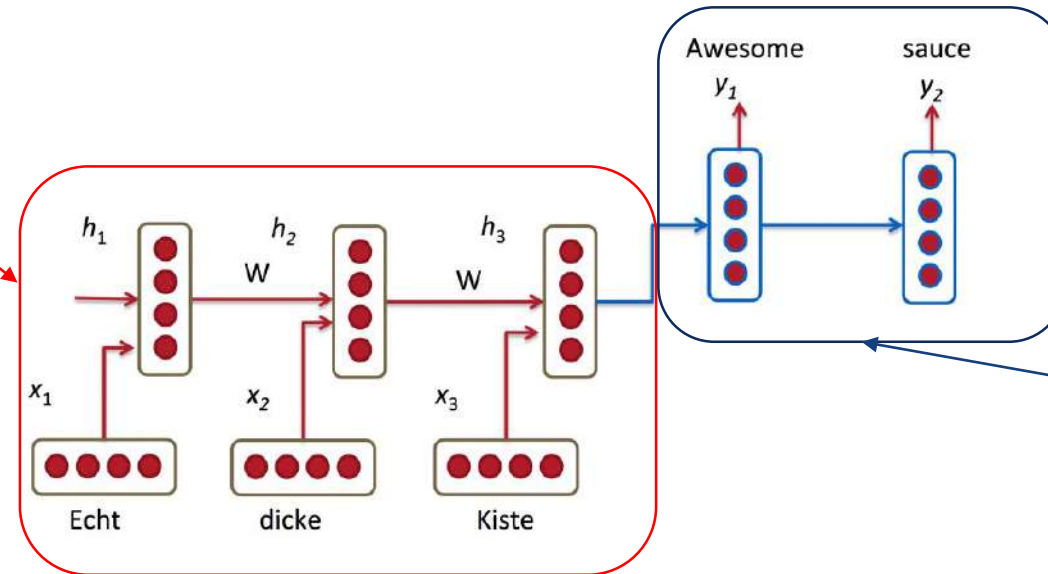
Uses the Google TensorFlow Machine Learning Library Inception model to detect object with camera frames in real-time, displaying the label and overlay on the camera image.

Detect 1001 objects in this model

# PR and ML Systems: Machine Translation

- The input is a sequence of words in source language, and the output is a sequence of words in target language.

Encoder: An RNN to encode the input sentence into a hidden state (feature)



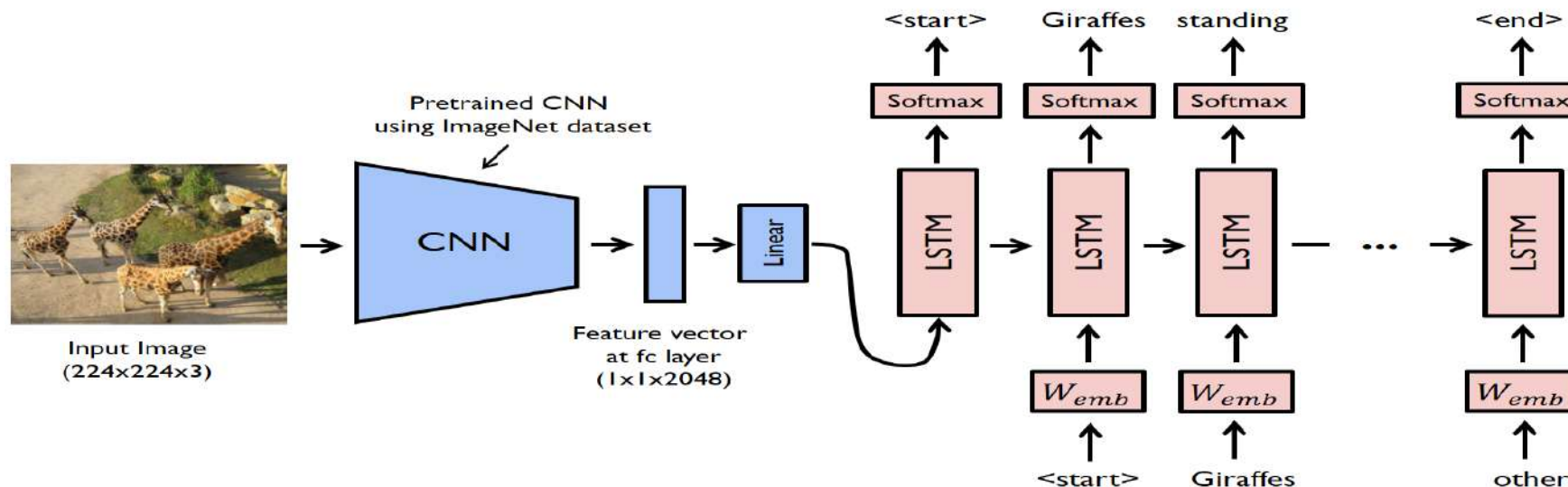
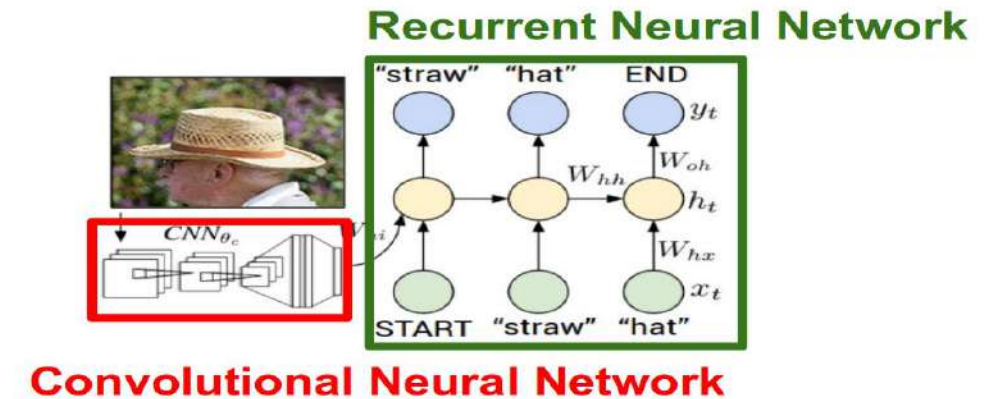
Decoder: An RNN with the hidden state of the sentence in source language as the input and output the translated sentence

Encoder-decoder architecture for machine translation

# PR and ML Systems: Image Captioning

Describing images

- Image captioning: CNN+LSTM



# PR and ML Systems: Ensemble

- **Active Random Forests: An application to Autonomous Unfolding of Clothes (ECCV 2014)**



[https://www.youtube.com/watch?v=ToAV\\_5mgN2Q](https://www.youtube.com/watch?v=ToAV_5mgN2Q)

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