Deep Learning

Dinesh Kumar Vishwakarma, Ph.D.

Associate Professor,

Department of Information Technology, DTU

dinesh@dtu.ac.in

http://www.dtu.ac.in/Web/Departments/InformationTechnology/faculty/dkvishwakarma.php

Course Structure

- Course Code: IT324
- Credit: 4C

✔ 3-Lecture

✔ 1-Tutorial or 1- Practical

✔ 6-modules

Syllabus

I	Introduction: Basics of deep learning, Importance of deep learning, Handcrafted vs Deep Features, Overview of deep learning framework.
II	Machine Learning Basics: Supervised learning algorithms, Hyper parameters and validation sets, overfitting, under fitting, Unsupervised learning algorithms, Stochastic Gradient Descent, Challenges motivating Deep Learning.
III	Deep feed forward network: Artificial Neural Network, activation function, multi-layer neural network, Training Neural Network: Risk minimization, loss function, backpropagation, regularization, model selection, and optimization, Data Augmentation, Dropout. Different activation functions, softmax cross entropy loss, Deep Vs Shallow Networks.
IV	Convolutional Neural Networks (CNN): Motivation, The Convolution Operation, Pooling, Stride, receptive fields, Structured outputs, Kernels. CNN Variants: LeNet-5, AlexNet, VGG-16, Inception Models, ResNet-50. CNN for object detection: RCNN, Faster RCNN, Fast RCNN, SSD, Yolo versions.
V	Recurrent and Recursive Nets: Recurrent Neural Networks (RNN) , Bidirectional RNNs, Deep Recurrent Networks, Recursive Neural Networks, Long-Term Dependencies, Long-Short Term Memory, Gated RNNs. Recent advancements: Generative adversarial network, auto-encoders
VI	Applications: Large scale deep learning, Computer vision, Speech Recognition, Natural Language Processing, Other applications, Deep Learning Tools and Libraries: Caffe, Theano, Keras.

Books/ Study Resources

Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
Chao Pan, Deep Learning Fundamentals: An Introduction for Beginners, Publisher Create Space Independent Publishing Platform, 2016, ISBN 1721230882, 9781721230884
Steven Cooper , Deep Learning for Beginners, data science, 2018
Python Deep Learning, by Valentino Zocca, Gianmario Spacagna, Daniel Slater, and Peter Roelants, Packt Publishing Ltd, 2017.
Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

https://cs230.stanford.edu/syllabus/ by **Andrew Ng**

https://www.youtube.com/playlist?list=PLzUTmXVwsnXod6WNdg57Yc3zFx_f-RYsq by **Fei-Fei Li**

https://cs231n.github.io/ **Fei-Fei Li**

Top Conferences

Rank	Publisher	Conference Details	H5-index	Impact Score
1	IEEE	CVPR : IEEE/CVF Conference on Computer Vision and Pattern Recognition	299	51.98
2	Neural Information Processing Systems Foundation	NeurIPS : Neural Information Processing Systems (NIPS) https://papers.nips.cc/paper/	198	33.49
3	IEEE	ICCV : IEEE/CVF International Conference on Computer Vision	176	32.51
4	Springer	ECCV : European Conference on Computer Vision	144	25.91
5	aaai	AAAI : AAAI Conference on Artificial Intelligence	126	25.57
6	PMLR	ICML : International Conference on Machine Learning (ICML)	171	18.48
7	IEEE	ICRA : IEEE International Conference on Robotics and Automation	94	15.84
8	Association for Computing Machinery	WWW : International World Wide Web Conferences (WWW)	80	14.69
9	Association for Computing Machinery	CHI : Conference on Human Factors in Computing Systems	95	13.7
10	Association for Computing Machinery	SIGKDD : ACM SIGKDD International Conference on Knowledge discovery and data mining	90	13.53

Top Journals/Transactions

Source title	Publisher
IEEE Transactions on Pattern Analysis and Machine Intelligence	IEEE
IEEE Transactions on Cybernetics	IEEE
IEEE Transactions on Systems, Man, and Cybernetics: Systems	IEEE
IEEE Transactions on Neural Networks and Learning Systems	IEEE
ACM Computing Surveys	ACM
IEEE Transactions on Image Processing	IEEE
International Journal of Computer Vision	Springer Nature
IEEE Transactions on Information Forensics and Security	IEEE
Pattern Recognition	Elsevier
IEEE Transactions on Affective Computing	IEEE
IEEE Transactions on Intelligent Transportation Systems	IEEE
ACM Transactions on Graphics	ACM
IEEE Transactions on Knowledge and Data Engineering	IEEE
IEEE Transactions on Signal Processing	IEEE
IEEE Transactions on Multimedia	IEEE
IEEE Transactions on Visualization and Computer Graphics	IEEE
IEEE Transactions on Cloud Computing	IEEE
Communications of the ACM	ACM
IEEE Transactions on Broadcasting	IEEE
Artificial Intelligence Review	Springer Nature
IEEE Transactions on Circuits and Systems for Video Technology	IEEE
IEEE Transactions on Human-Machine Systems	IEEE
IEEE Transactions on Antennas and Propagation	IEEE
Computer Vision and Image Understanding	Elsevier

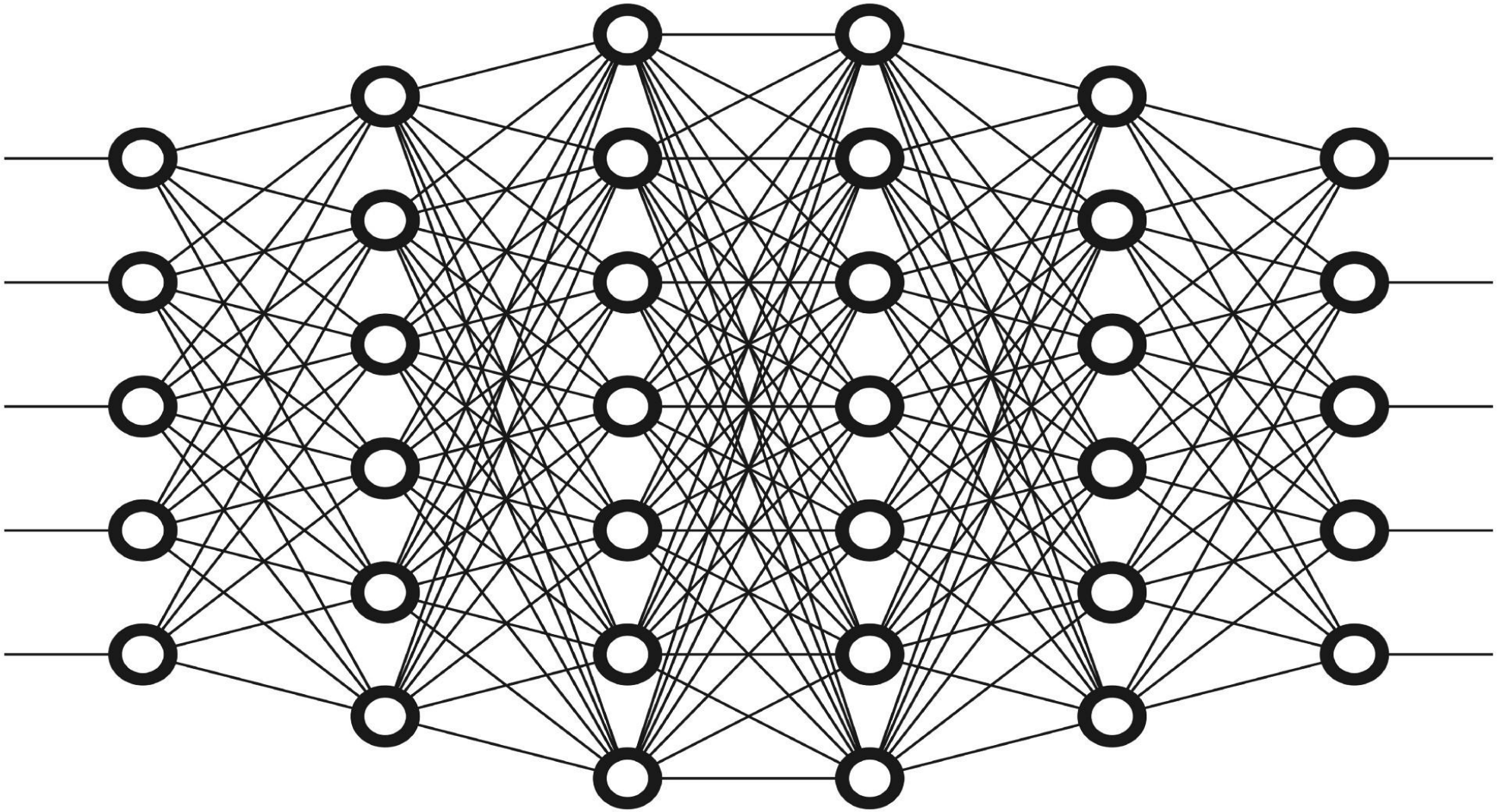
Research Metrics

- Citations Counts
- Research Impact
- H-index
- I-10 index
- Impact Factor
- Cite Score

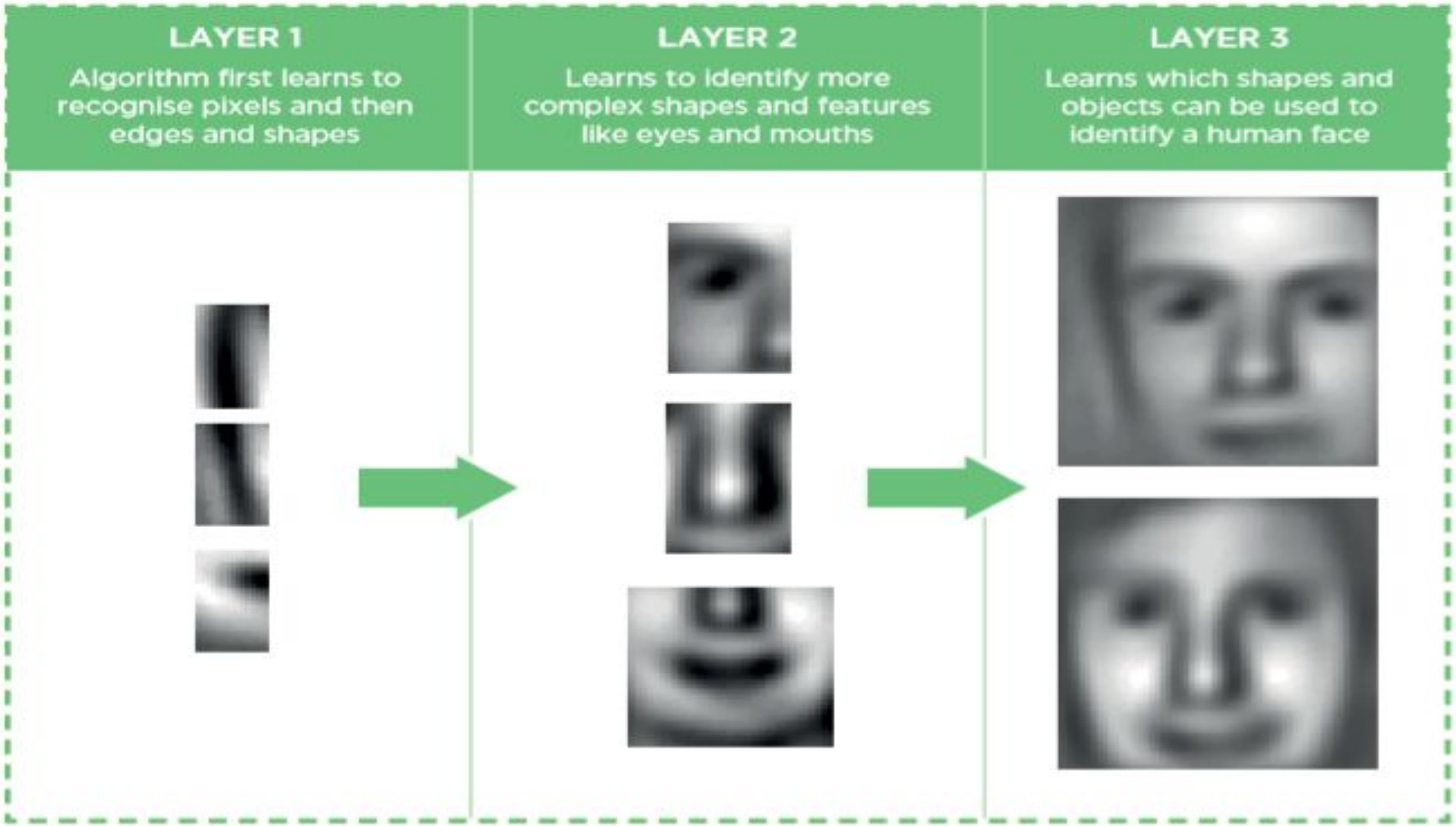
What is Deep Learning?

- Deep Learning is a subset of Machine Learning.
- It achieves countless power and flexibility by learning to represent the world as nested **hierarchy** of concepts.
- Each concept defined in relation to simpler concepts, and more abstract representations computed in terms of less abstract ones.
- A deep learning technique learn categories incrementally through it's hidden layer architecture, defining low-level categories like **letters** first then little higher level categories like **words** and then higher level categories like **sentences**.

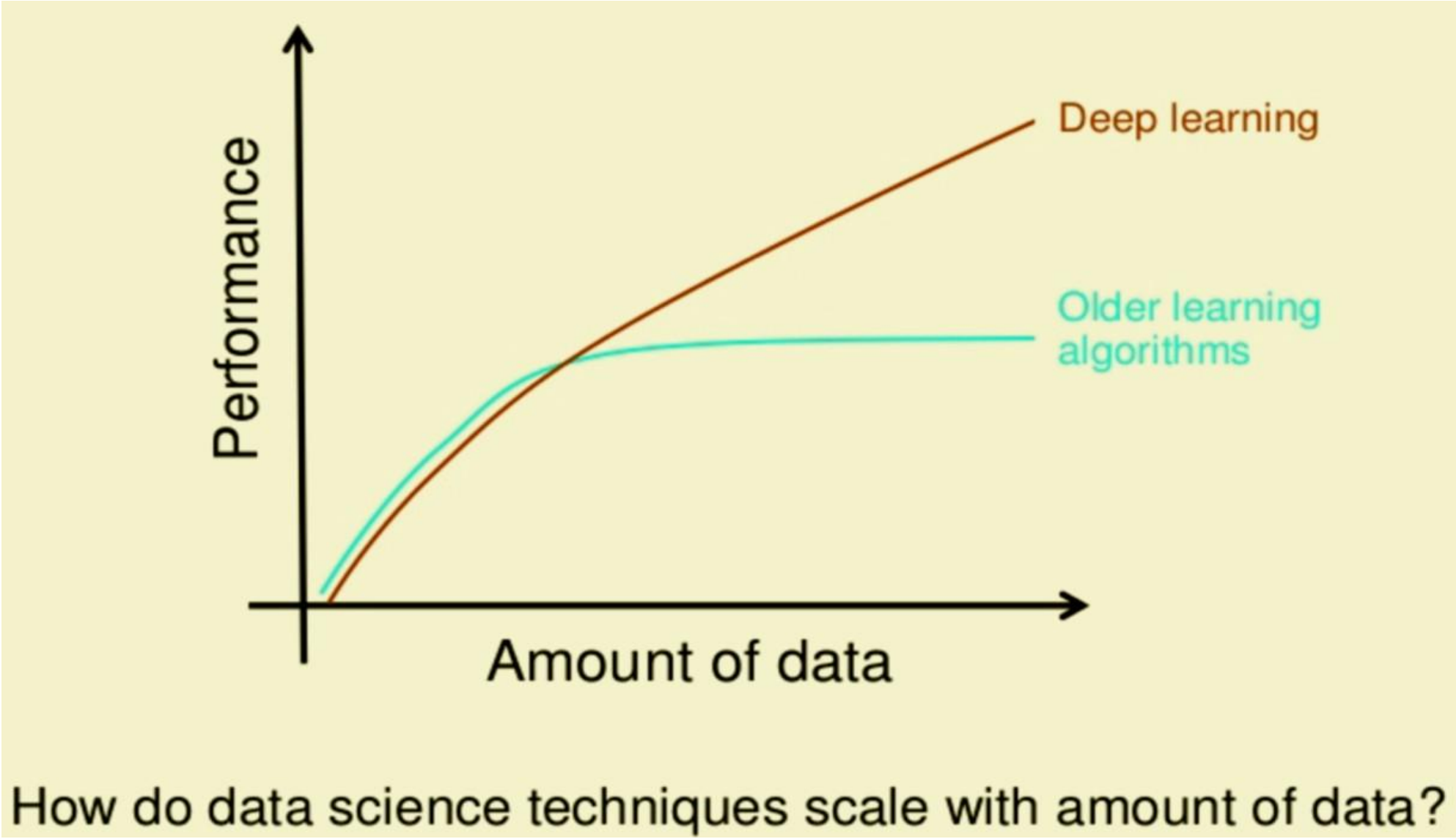
Deep Architecture



Deep Architecture: Layers



Why Deep Learning?

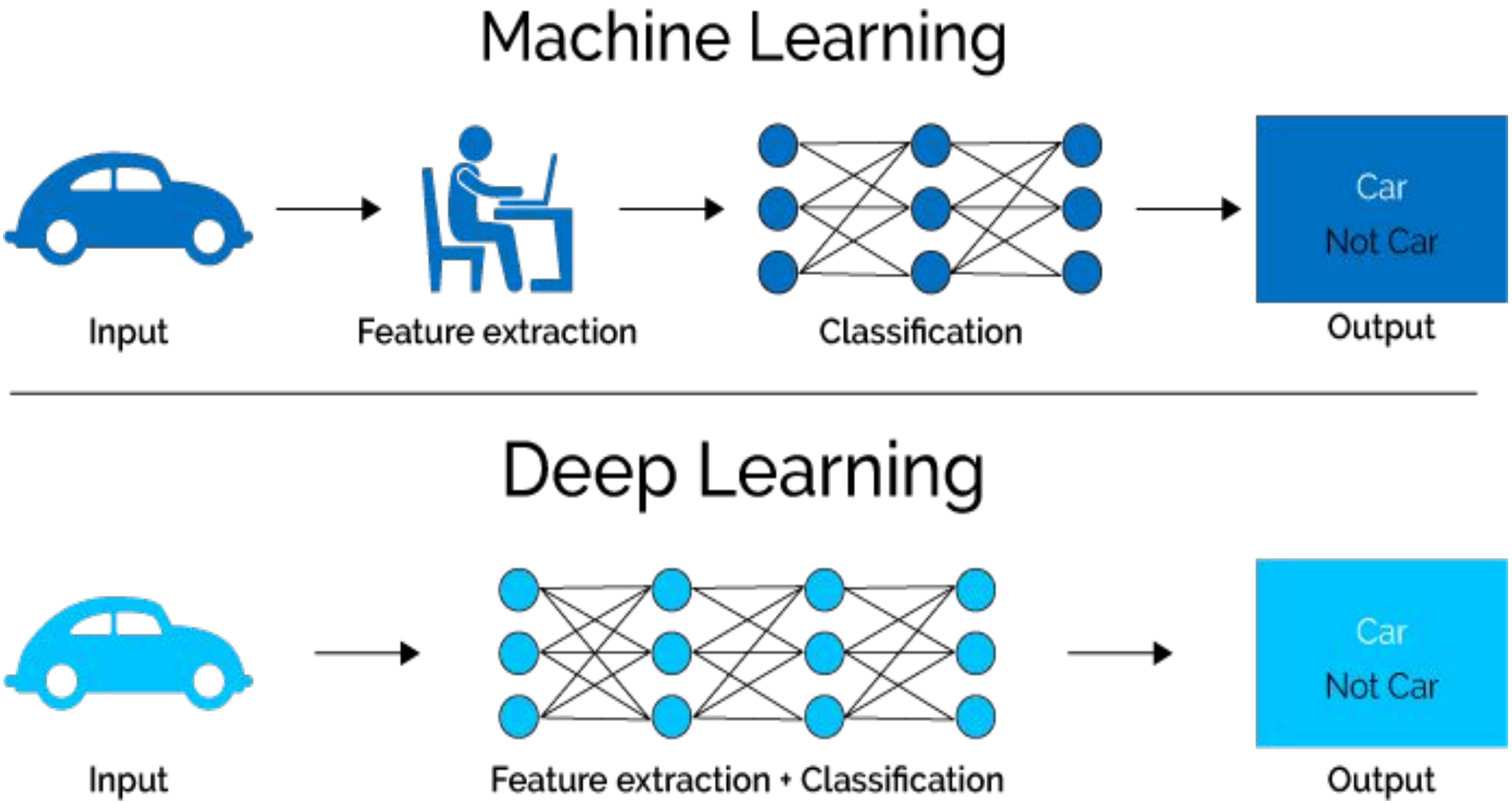


How do data science techniques scale with amount of data?

Key Features: DL

- **Deep Learning** requires high-end machines contrary to traditional **Machine Learning** algorithms. GPU has become a integral part now to execute any **Deep Learning** algorithm.
- **ML** techniques requires applied features that need to be identified by an domain expert in order to reduce the complexity of the data and make patterns more visible to learning algorithms to work.
- The biggest advantage **DL** algorithms are that it try to learn high-level features from data in an incremental manner. This eliminates the need of domain expertise and hard core feature extraction.

DL vs ML

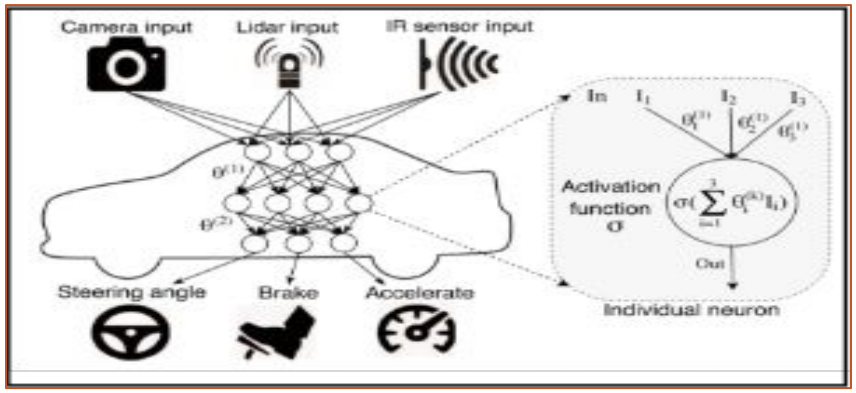

Machine Learning
Input
Feature extraction
Classification
Car
Not Car
Output
Deep Learning
Input
Feature extraction + Classification
Car
Not Car
Output

AI is UBIQUITOUS

- Automate routine labor
  - Search

- Understand speech
  - SIRI, Alexa

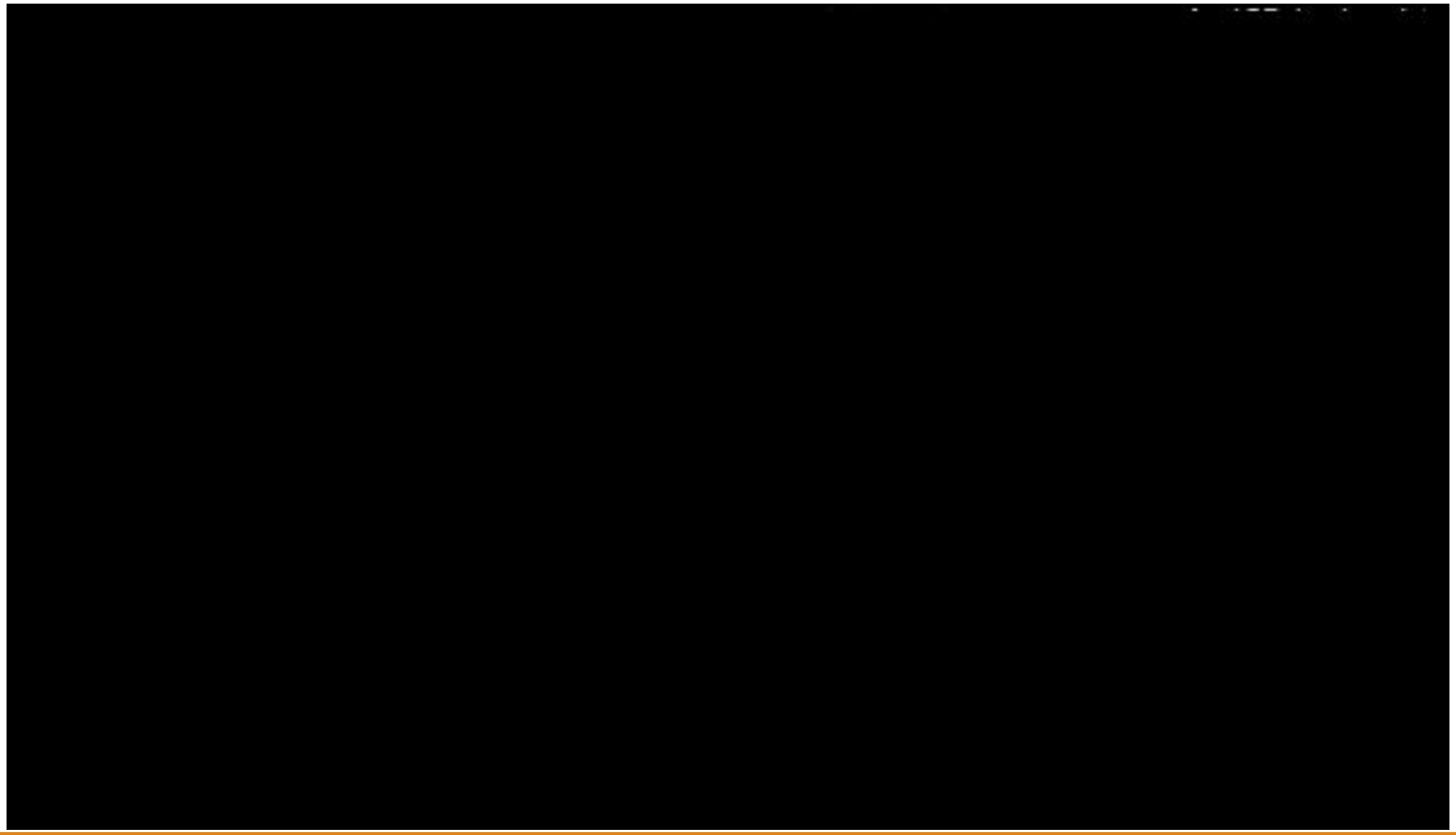
- Autonomous Vehicles



Applications of Deep Learning

- Self Driving Cars
- News Aggregation and Fraud News Detection
- Natural Language Processing
- Entertainment
- Visual Recognition
- Fraud Detection
- Healthcare
- Personalization's
- Colorization of Black and White images
- Adding sounds to silent movies
- Automatic Machine Translation
- Automatic Handwriting Generation
- Automatic Game Playing
- Language Translations
- Pixel Restoration
- Photo Descriptions
- Deep Dreaming

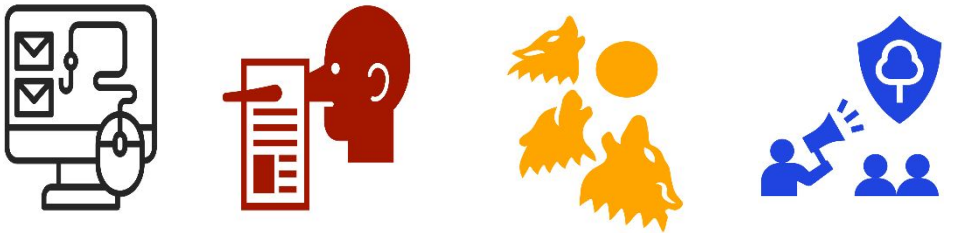
Self Driving Car

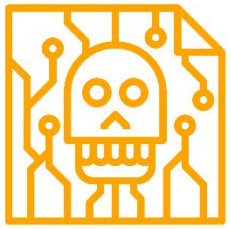


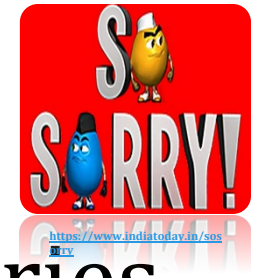
https://www.csail.mit.edu/news/new-deep-learning-models-require-fewer-neurons

News Aggregation and Fraud News Detection

- ✔ Rumour
- ✔ Fake News
- ✔ Misinformation
- ✔ Disinformation
- ✔ Clickbait
- ✔ Hoax
- ✔ Satire
- ✔ Opinion Spam
- ✔ Propaganda
- ✔ Conspiracy Theories







https://www.indiatoday.in/sos

provocative woman in thumnail that didn't appear in the video

https://scroll.in/article/826034/bjp-claims-uae-has-seized-dawoods-property-but-the-source-of-the-information-remains-unclear

Natural Language Processing

Virtual Assistants

Alexa An amazon.com company

Google Assistant

Determine Client Needs

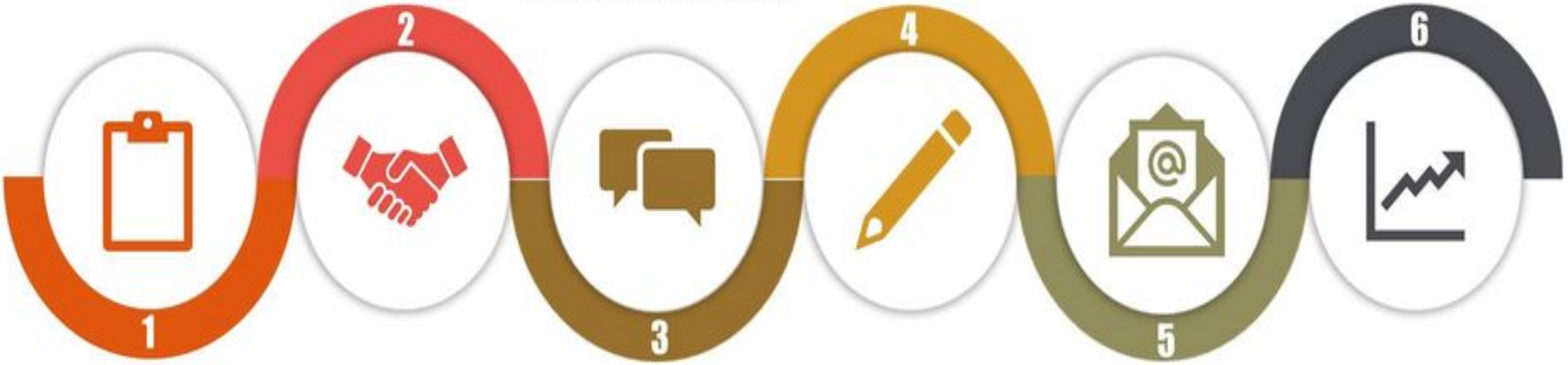
For us to provide the right Virtual Assistant, we would obviously need to identify your business needs.

Knowledge Transfer

To make sure that our VA will be able to do the tasks effectively and in accordance with your processes, trainings will be conducted and the necessary documents will be shared.

Reporting and Evaluation

Daily and weekly reports of the tasks accomplished will be sent to you by our VA for you to assess the performance of your outsourced staff.



Agreement

We will discuss the details of the project, set the scope of our service, and establish a contract.

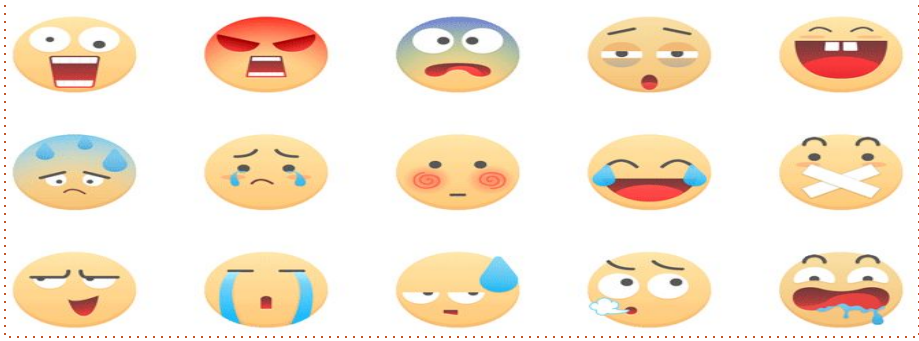
Execution

Once the knowledge transfer is completed, our VA will start providing the services that you need.

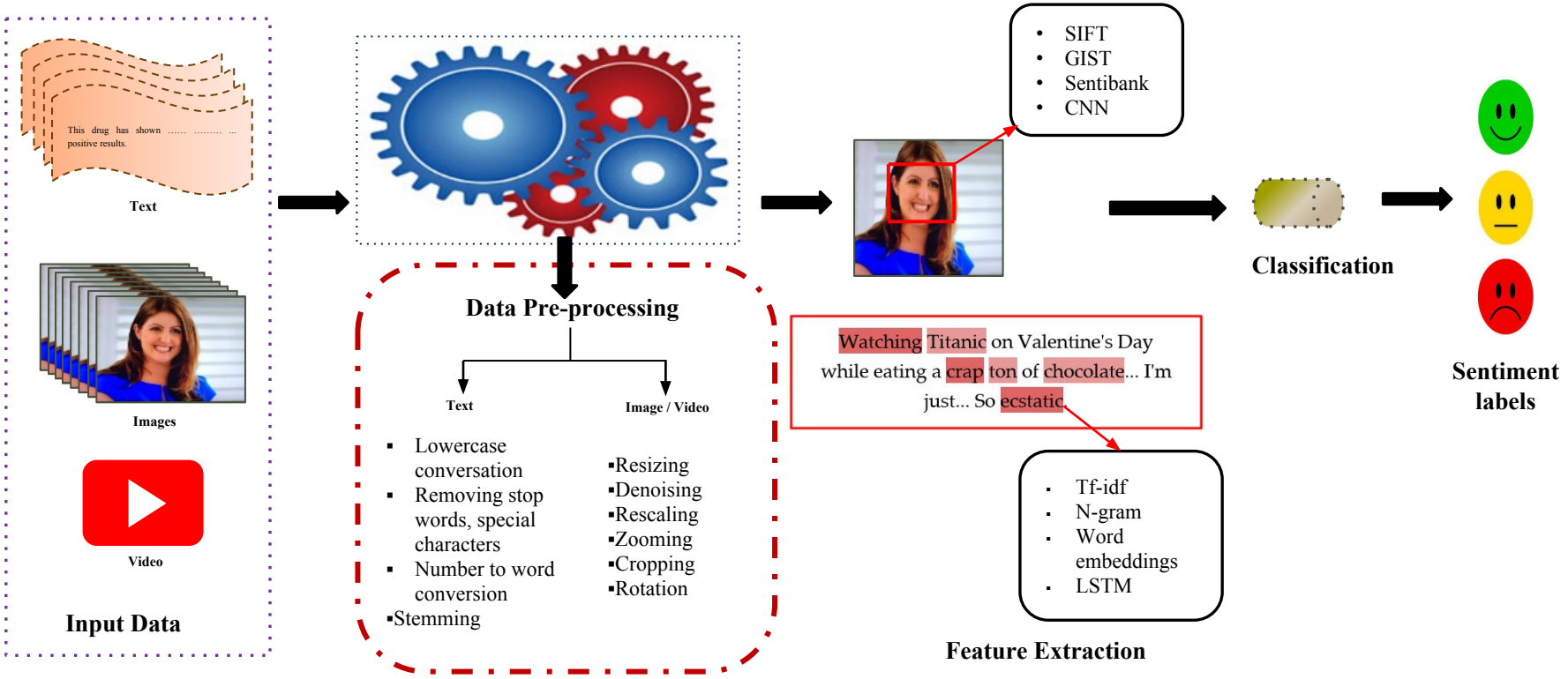
Improvement

Based on your assessment and feedback, we will help our VA to improve and deliver maximum client satisfaction.

Entertainments

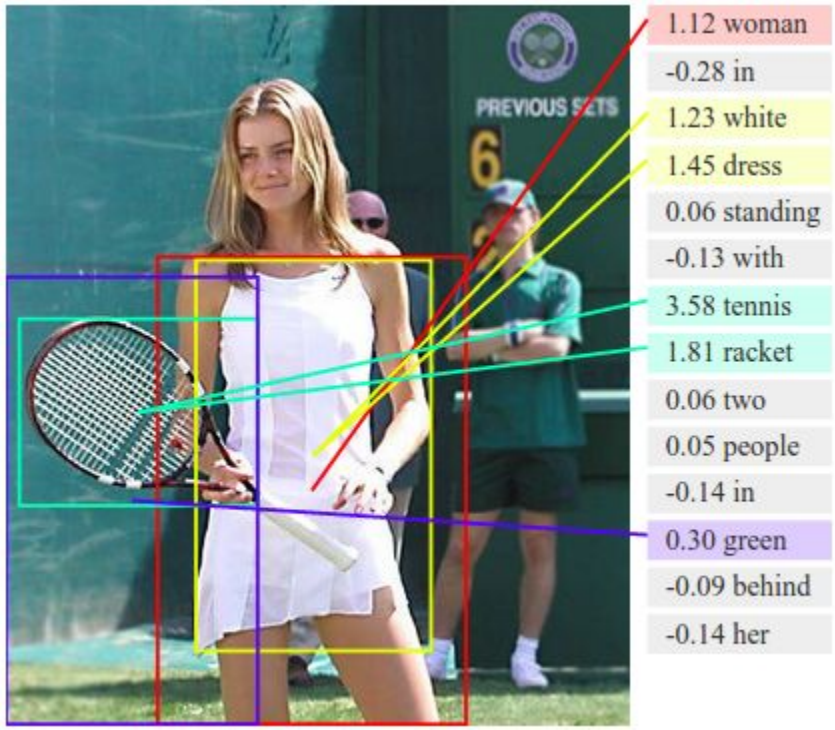


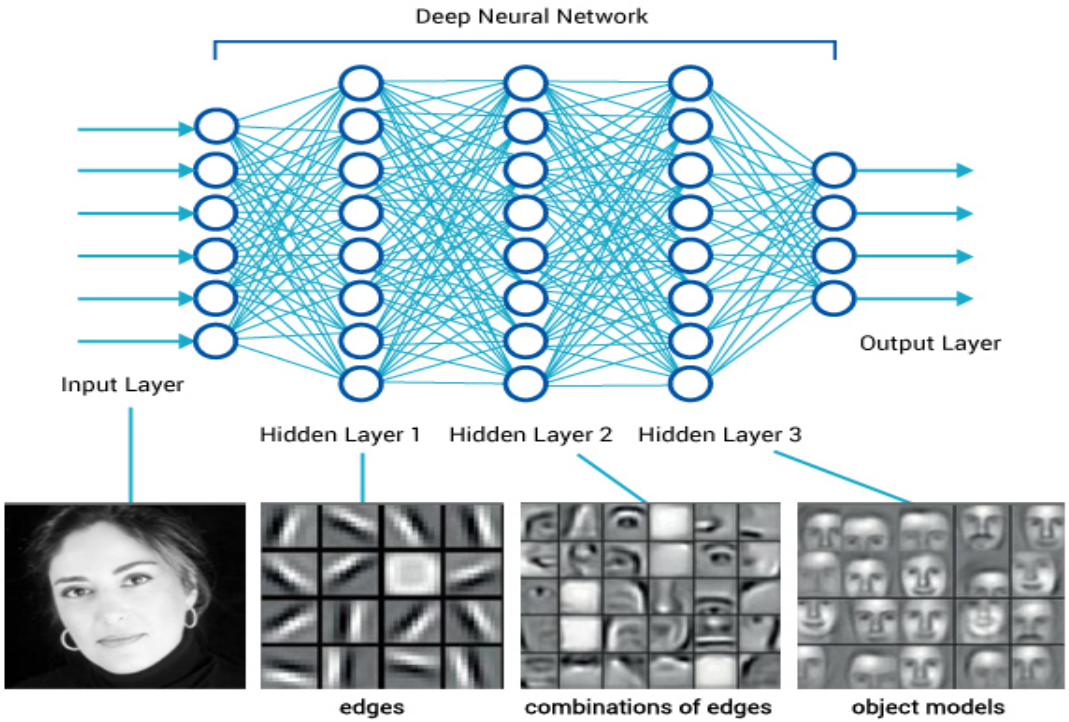
- Analyse player emotions and expressions through hundreds of hours of footage to auto-generate highlights for telecast.
- Deep video analysis can save hours of manual effort required for audio/video sync and its testing, transcriptions, and tagging.



Visual Recognition

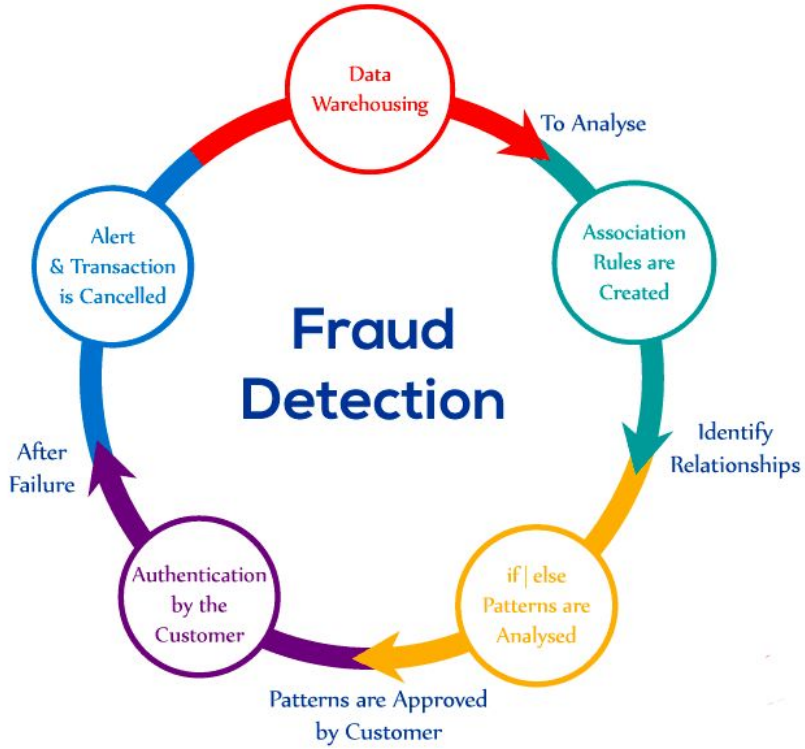
- Images can be sorted based on locations detected in photographs, faces, a combination of people, or according to events, dates, etc.
- Searching for a particular photo from a library.

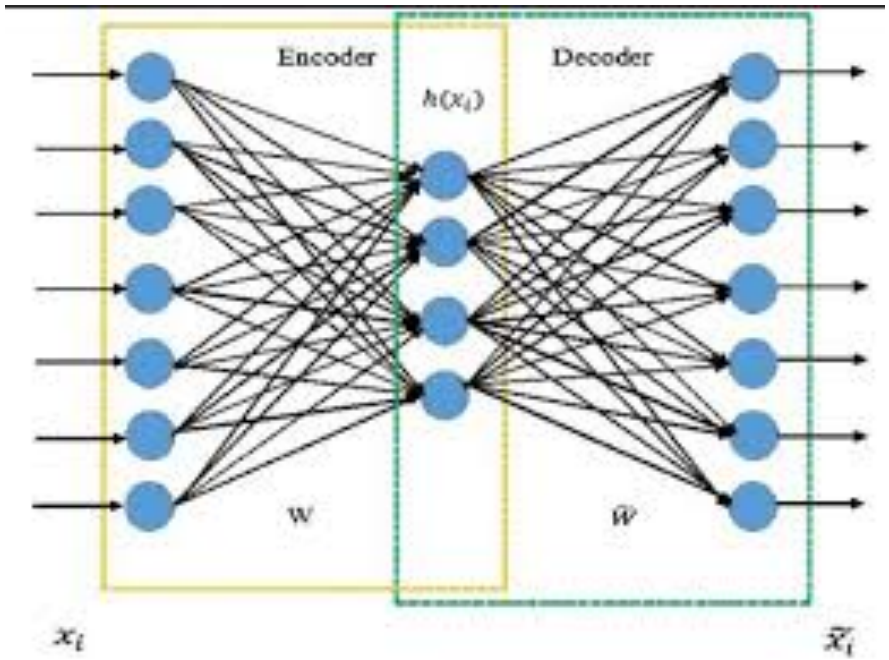




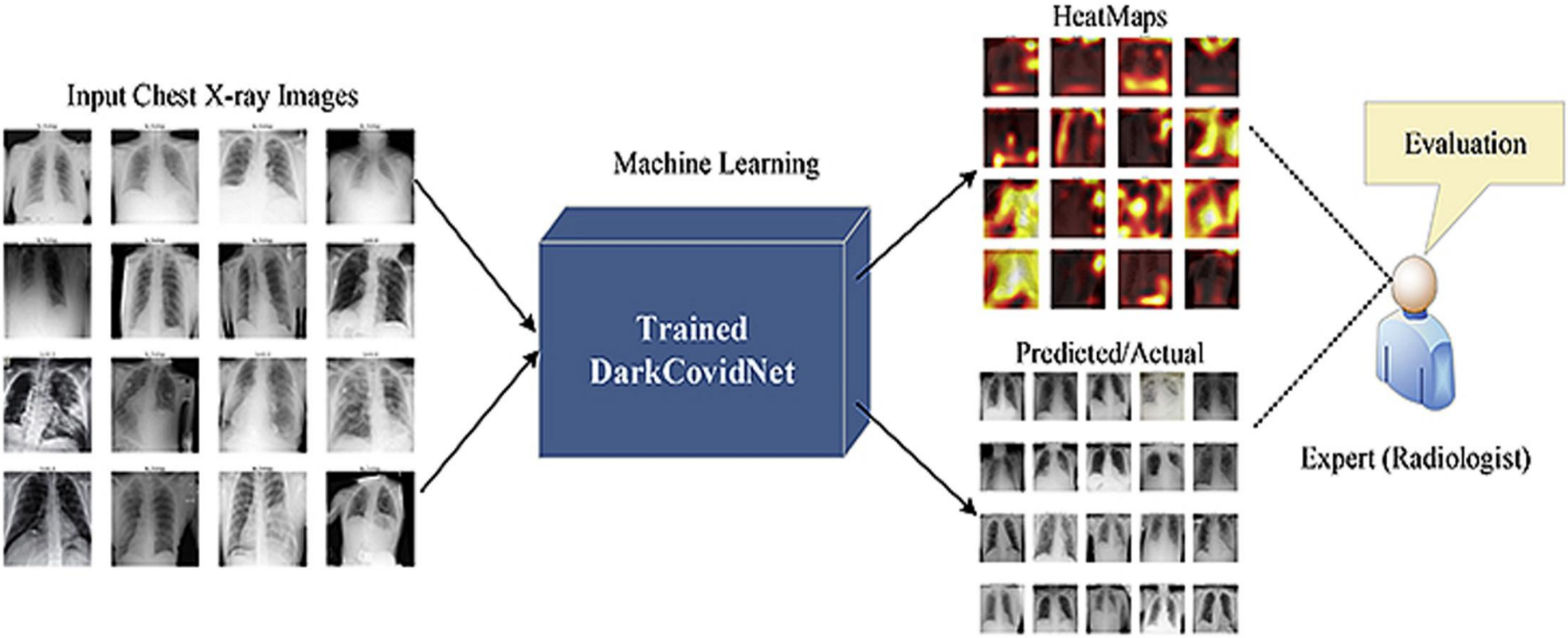
Fraud Detection

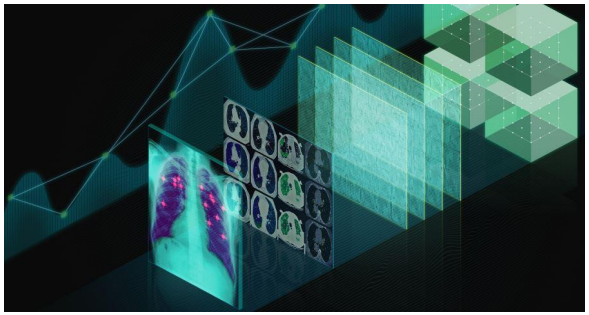
- Banking and financial sector: Fraud detection during digital money transactions.
- Autoencoders are used to detect credit card frauds saving billions of dollars of cost in recovery and insurance for financial institutions.
- Fraud prevention and detection are done based on identifying patterns in customer transactions and credit scores, identifying anomalous behavior and outliers.

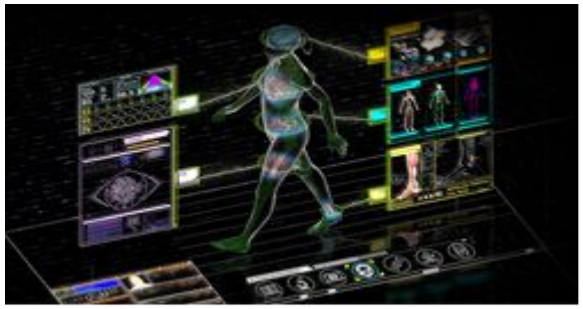




Healthcare

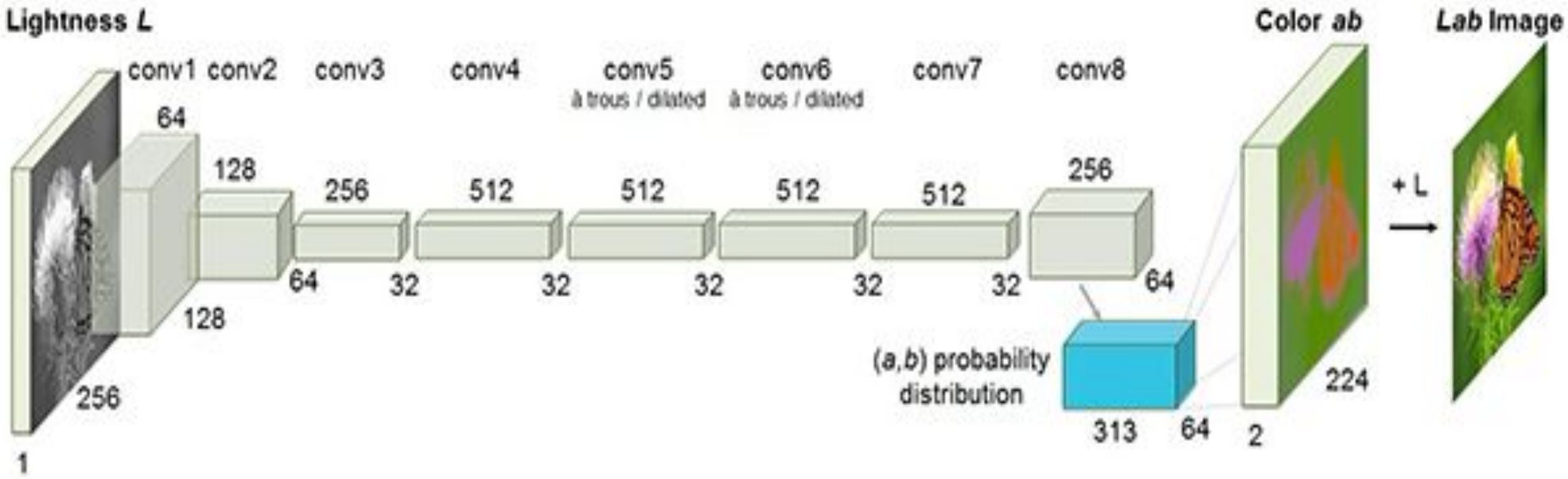

Input Chest X-ray Images
Machine Learning
Trained
DarkCovidNet
HeatMaps
Predicted/Actual
Evaluation
Expert (Radiologist)



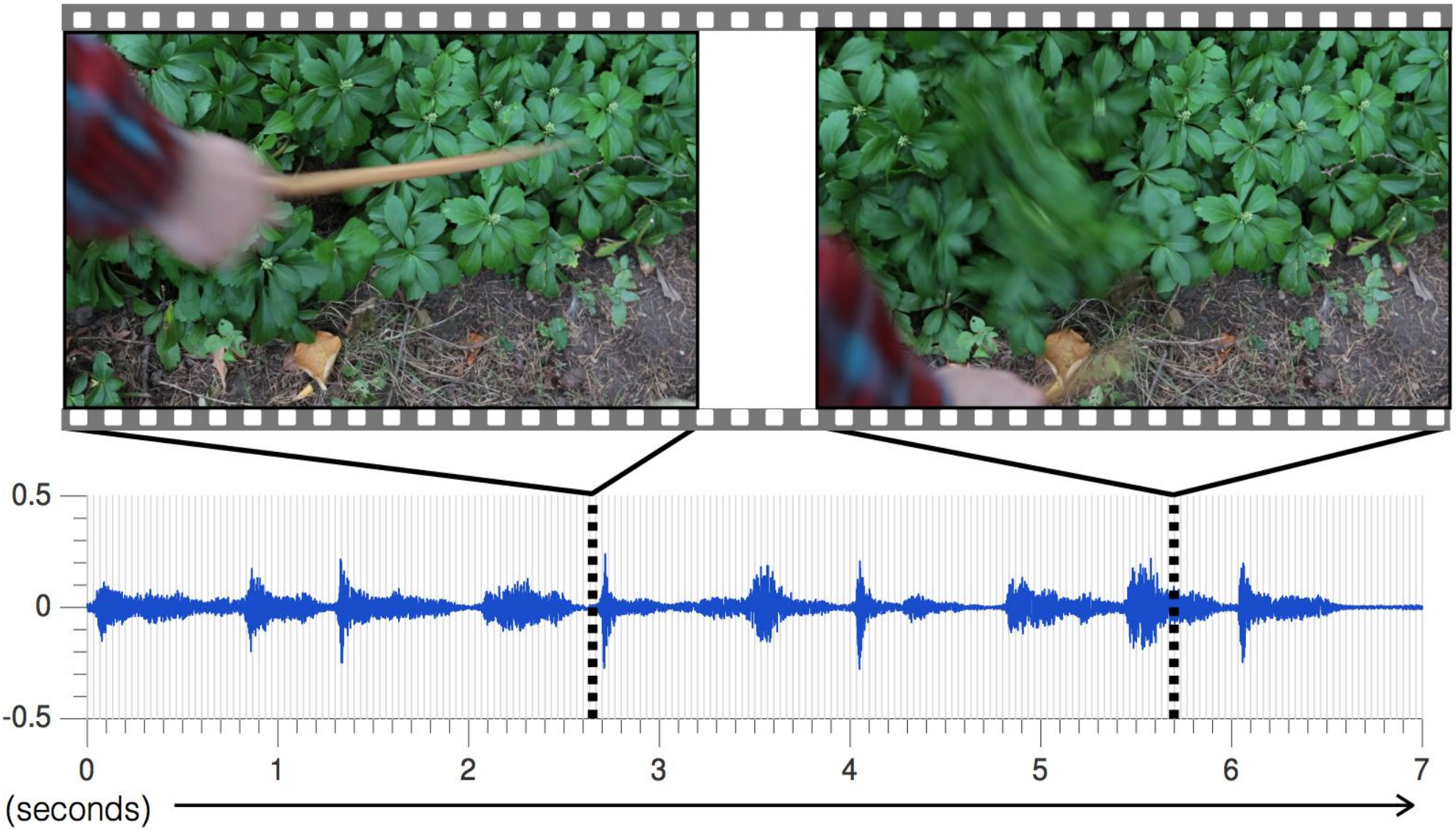


Colorization of Black and White Images

- Image colorization is the process of taking grayscale images (as input) and then producing colorized images (as output) that represents the semantic colors and tones of the input.
- This process, was conventionally done by hand with human effort, considering the difficulty of the task

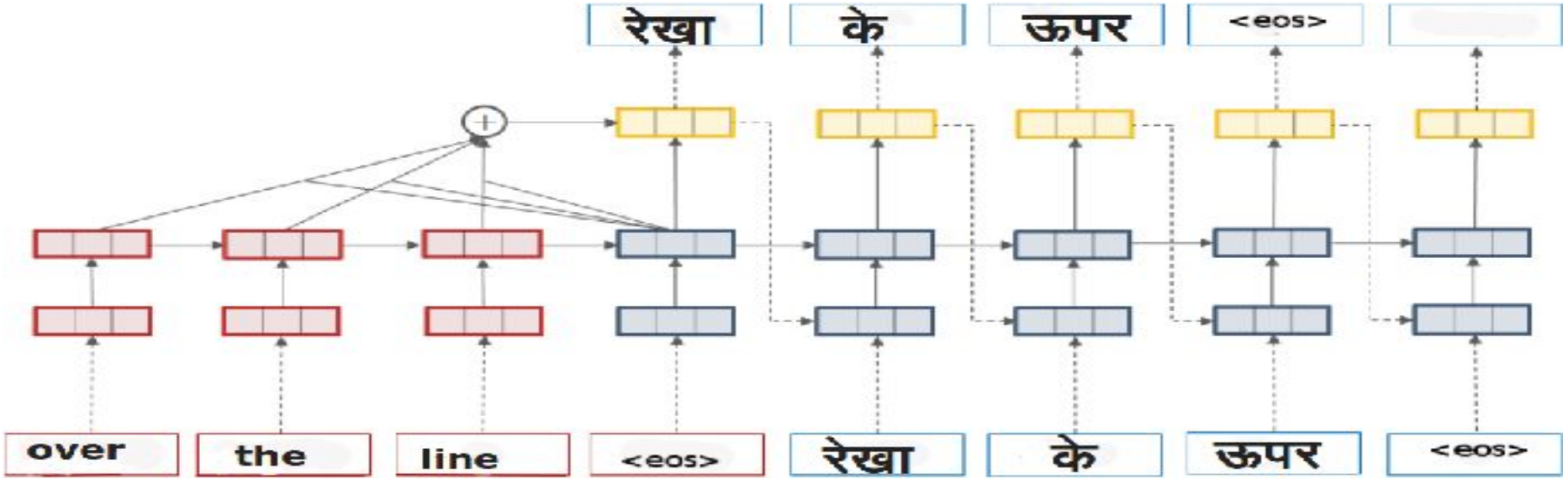


Adding Sounds To Silent Movies



Automatic Machine Translation

- The ability to communicate with one another is a fundamental part of being human. There are nearly 7,000 different languages worldwide.
- Purpose: Business, Commerce, Media, Education, Government.
- CNNs are useful in identification of images that have visible letters. Once identified, they can be turned into text, translated and recreated with an image using the translated text. This process is called Instant visual translation.

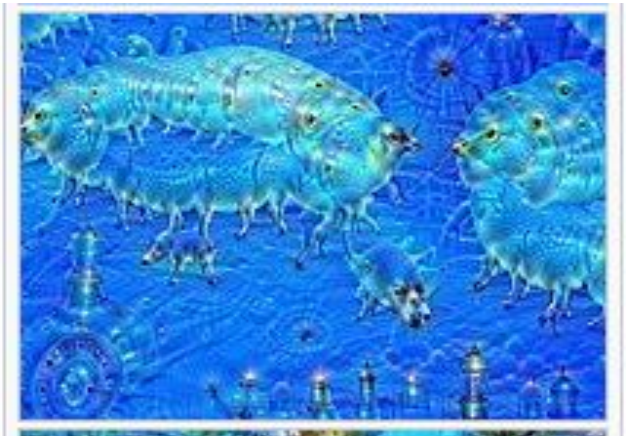


Deep Dreaming

hallucinogenic दृष्टिभ्रमकारी

- DeepDream is a computer vision program created by Google engineer Alexander Mordvintsev that uses a convolutional neural network to find and enhance patterns in images via algorithming a dream-like hallucinogenic appearance in the deliberately over-processed images.

Original image



10 iteration of deep dream

50 iteration of deep dream

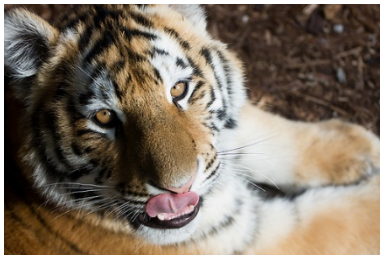
Deepfakes

Learning Types

- Supervised Learning
  - ✔ Convolutional Neural Network
  - ✔ Sequence Modelling: RNN and its extensions
- Unsupervised Learning
  - ✔ Autoencoder
  - ✔ Stacked Denoising Autoencoder
- Reinforcement Learning
  - ✔ Deep Reinforcement Learning

Traditional ML System

- Traditional pattern recognition models use hand-crafted features and relatively simple trainable classifier.



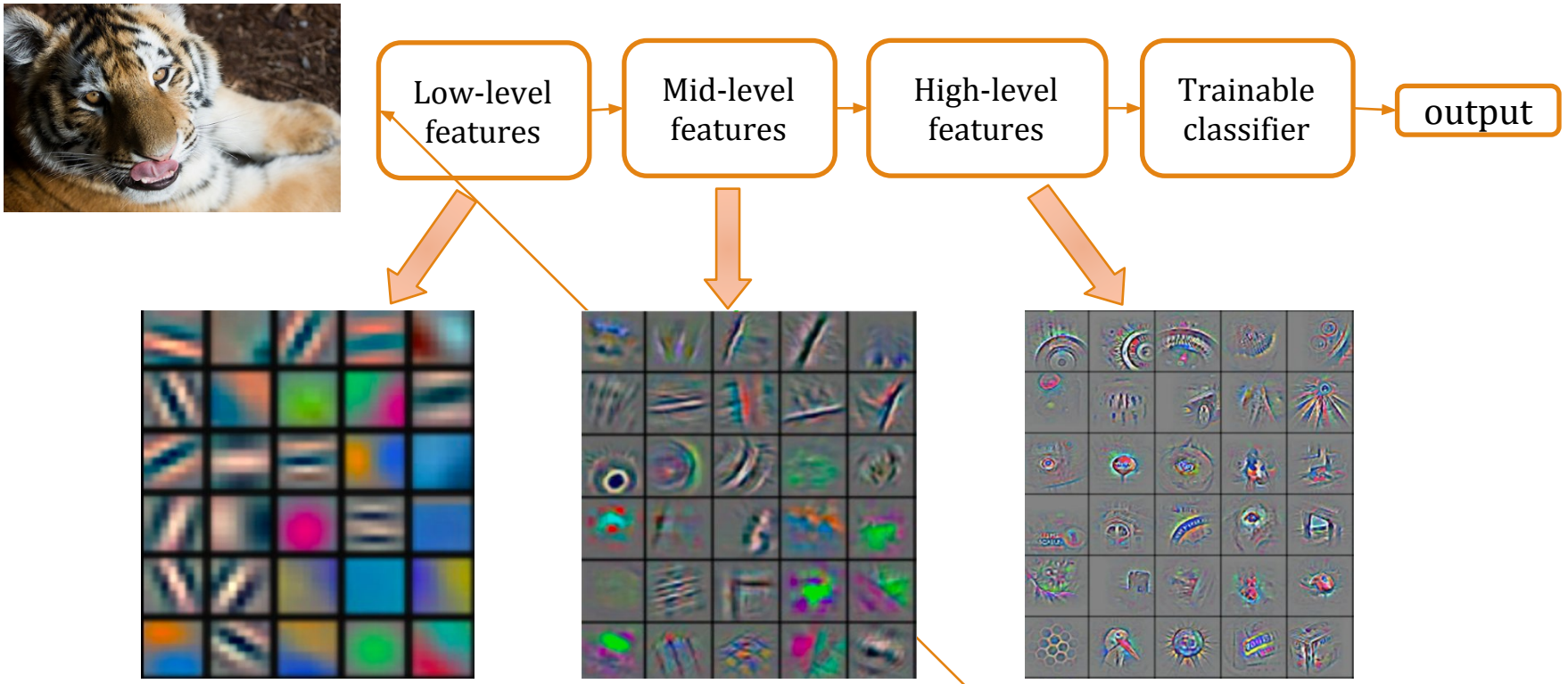
- This approach has the following limitations:

✔ It is very tedious and costly to develop hand-crafted features

✔ The hand-crafted features are usually highly dependents on one application, and cannot be transferred easily to other applications.

Deep Learning System

- Deep learning (a.k.a. representation learning) seeks to learn rich hierarchical representations (i.e. features) automatically through multiple stage of feature learning process.



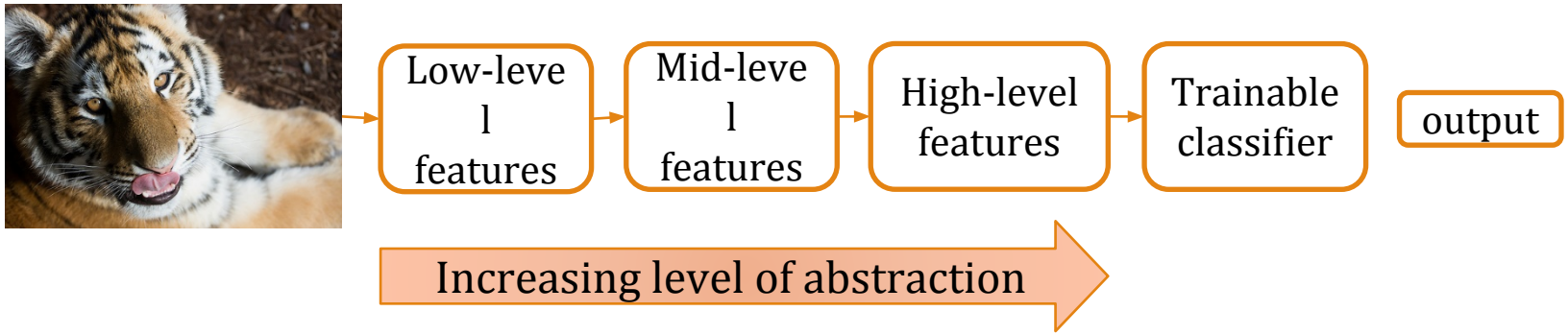
Learning Hierarchical Representations

- Hierarchy of representations with increasing level of abstraction. Each stage is a kind of trainable nonlinear feature transform
- Image recognition

✔ Pixel → edge → texton → motif → part → object

- Text

✔ Character → word → word group → clause → sentence → story



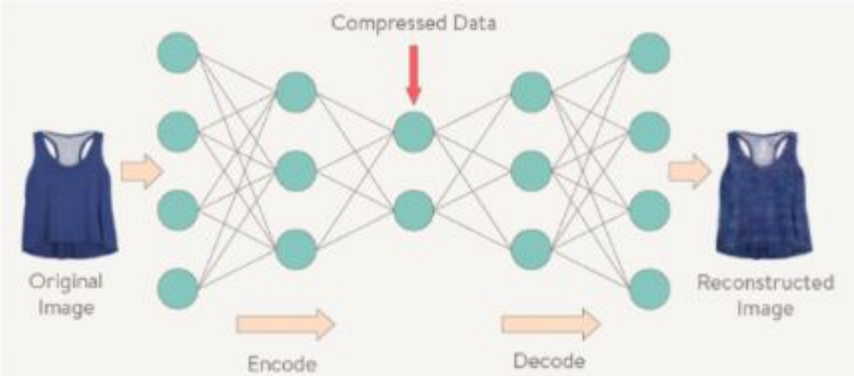
Why DL is useful?

- 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**, (almost?) **universal**, learnable framework for representing world, visual and linguistic information.
- Can learn both unsupervised and supervised
- Effective **end-to-end** joint system learning
- Utilize large amounts of training data

Unsupervised Representation Learning

- Autoencoder:
  - Quintessential example of representation learning
  - Encoder:
    - Converts input into a representation with nice properties
  - Decoder:
    - Converts the representation back to input

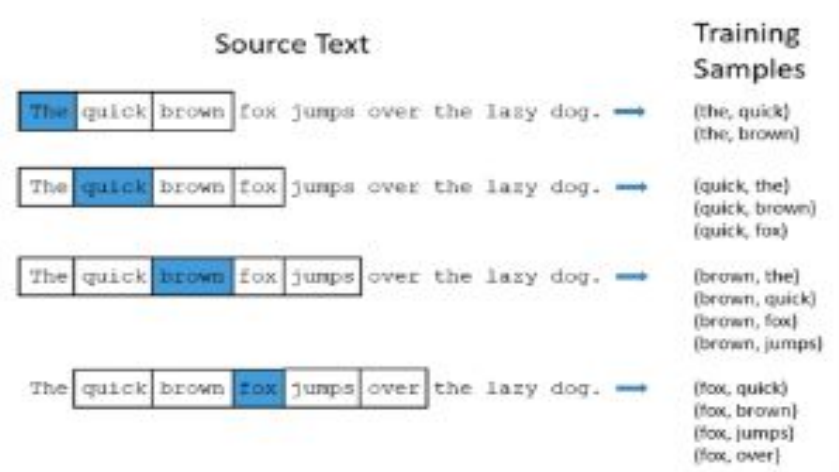
Deep Style

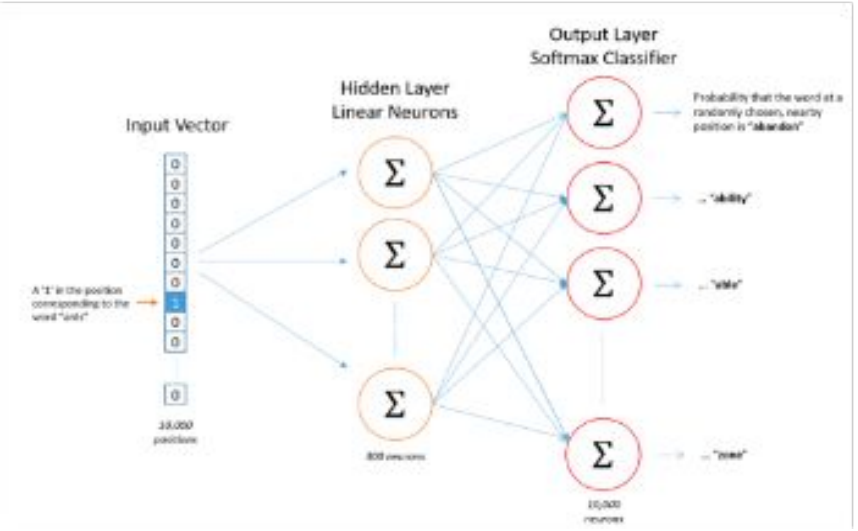


New designs from representation

Natural Language Processing

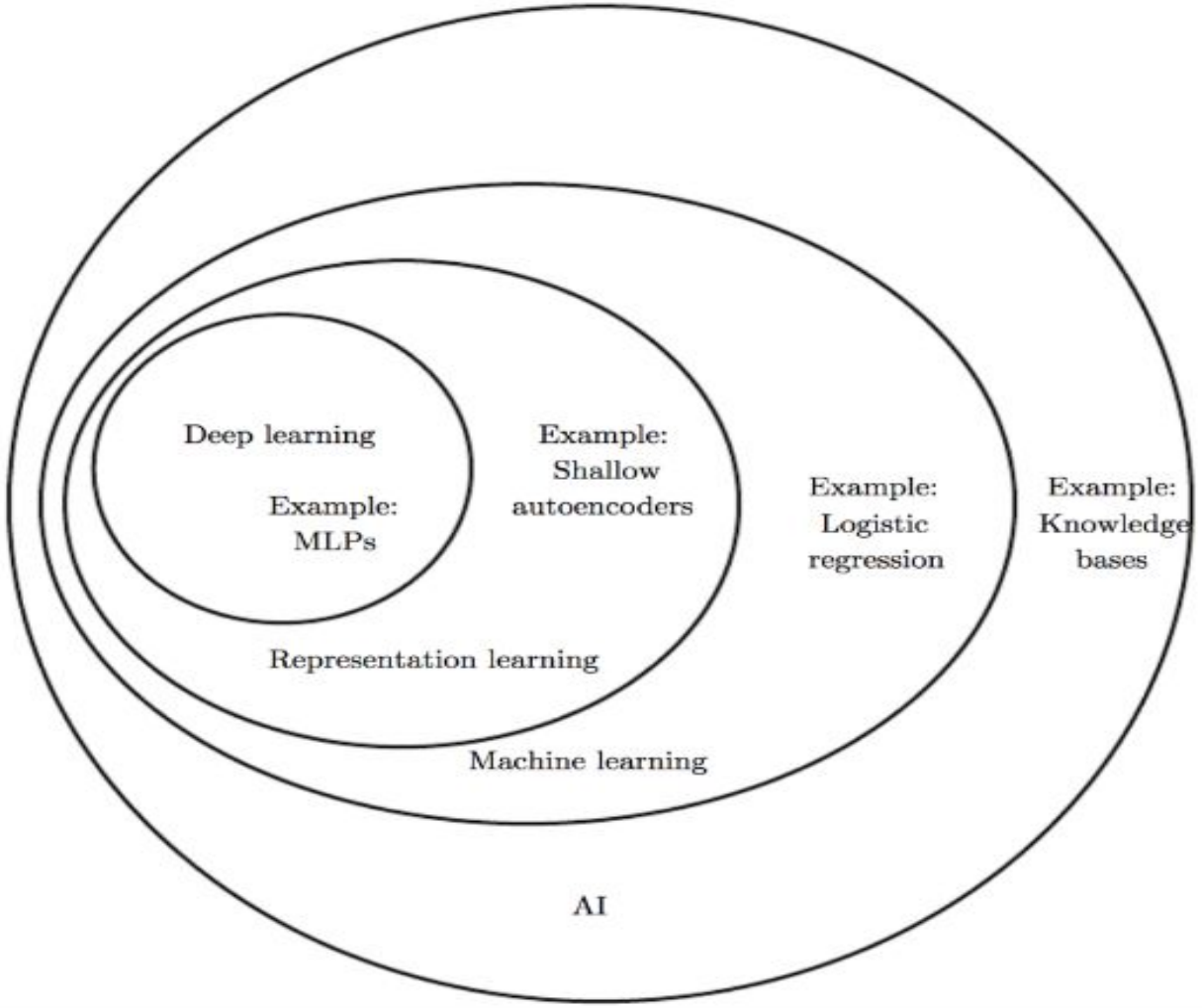
- Training Data
- Word-to-vec
  - One-hot vector mapped to vector of 300
- Word embedding
  - Similar words are close together





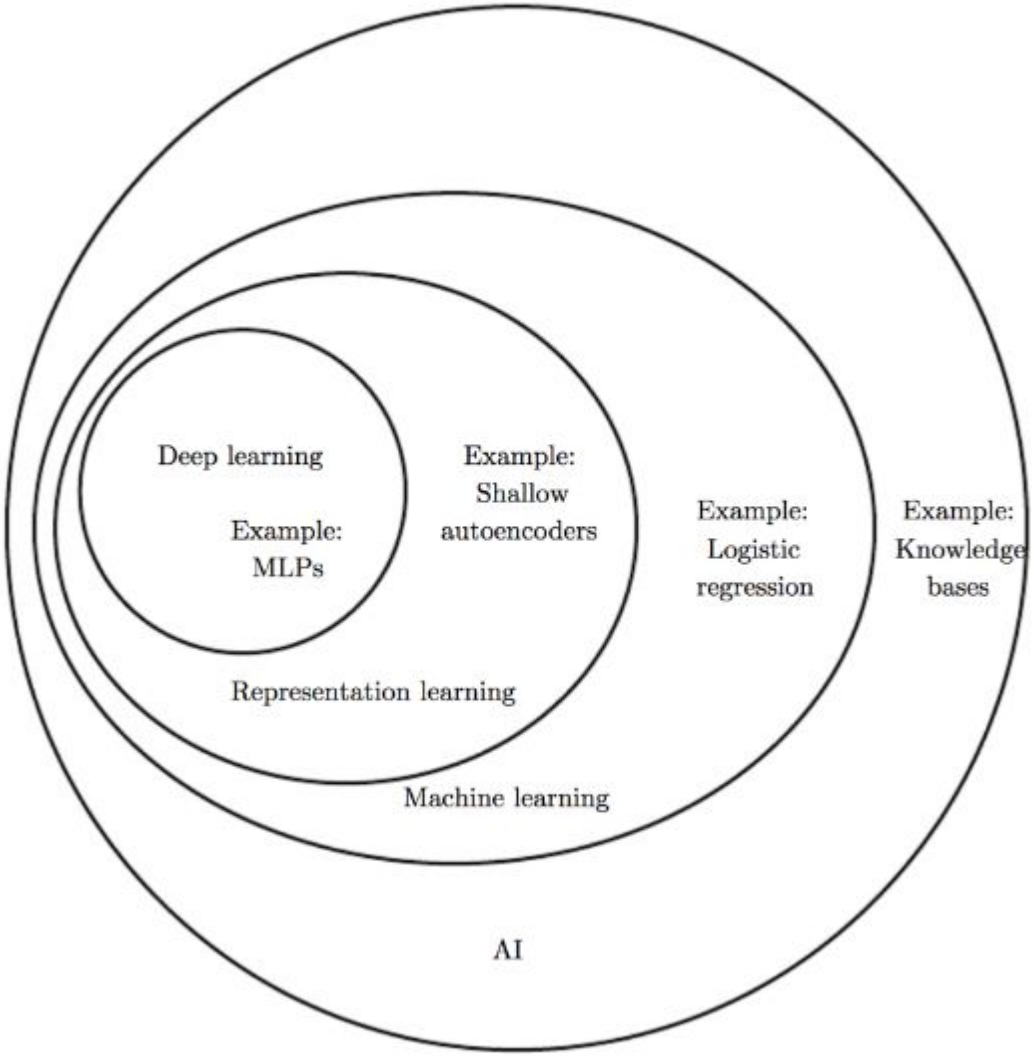
AI, ML and DL

- AI methods Deep Learning is a type of representation learning



Approaches to AI: Venn Diagram

- AI methods
- Deep Learning is a type of representation learning
- An example AI technology is included in each
- Also see



https://blogsinsider.blogspot.com/2018/10/relationship-between-ai-ml-dl.html