AI-ASSOCIATED TECHNOLOGIES

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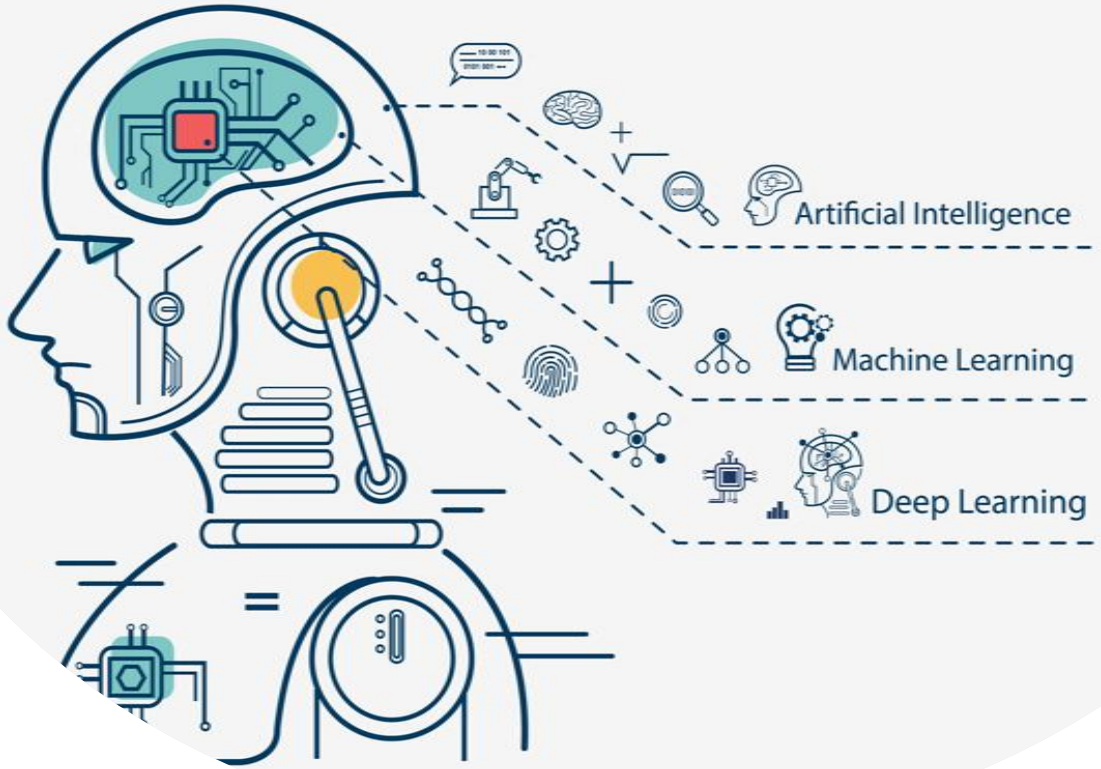
OUTLINE

- AI basics
- AI types
- Machine Learning
- R and Python programming
- TensorFlow
- Additional AI Frameworks
- Healthcare applications
- Smart city applications



AI BASICS

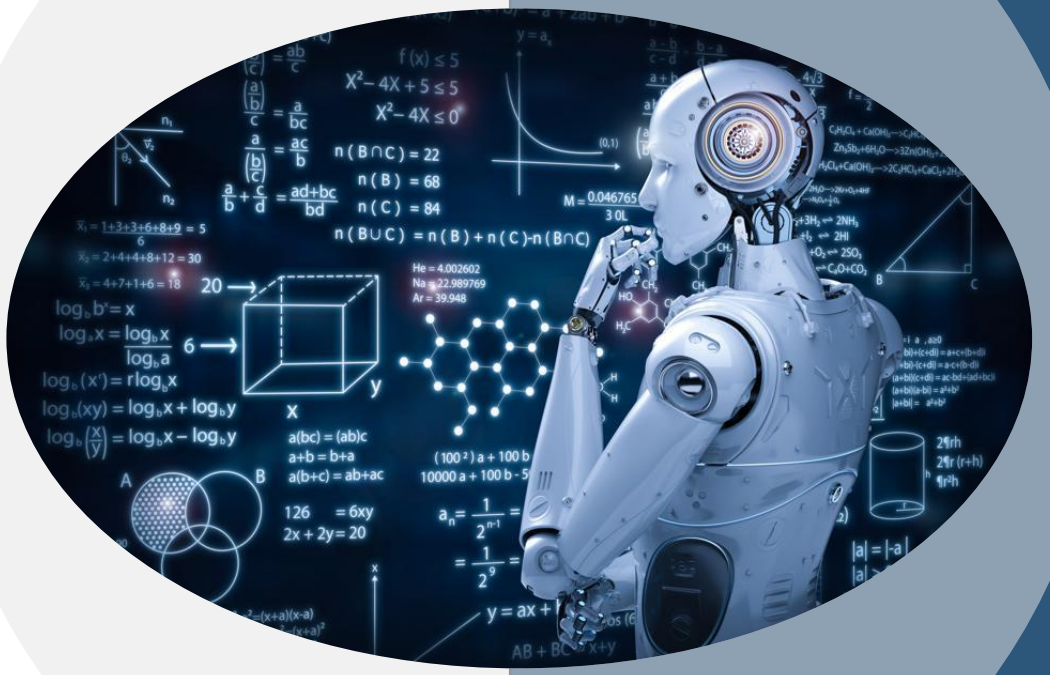
Natural intelligence is demonstrated by animals and humans

Artificial intelligence is the intelligence demonstrated by machines

The AI machines are smart machines capable of performing cognitive tasks that typically require human intelligence including perceiving, reasoning, learning, interacting

AI applications include speech recognition, recommending products, advanced web search engines, self-driving cars, automated decision-making and gaming

Advancements in machine learning and deep learning are creating a paradigm shift in the tech industry.

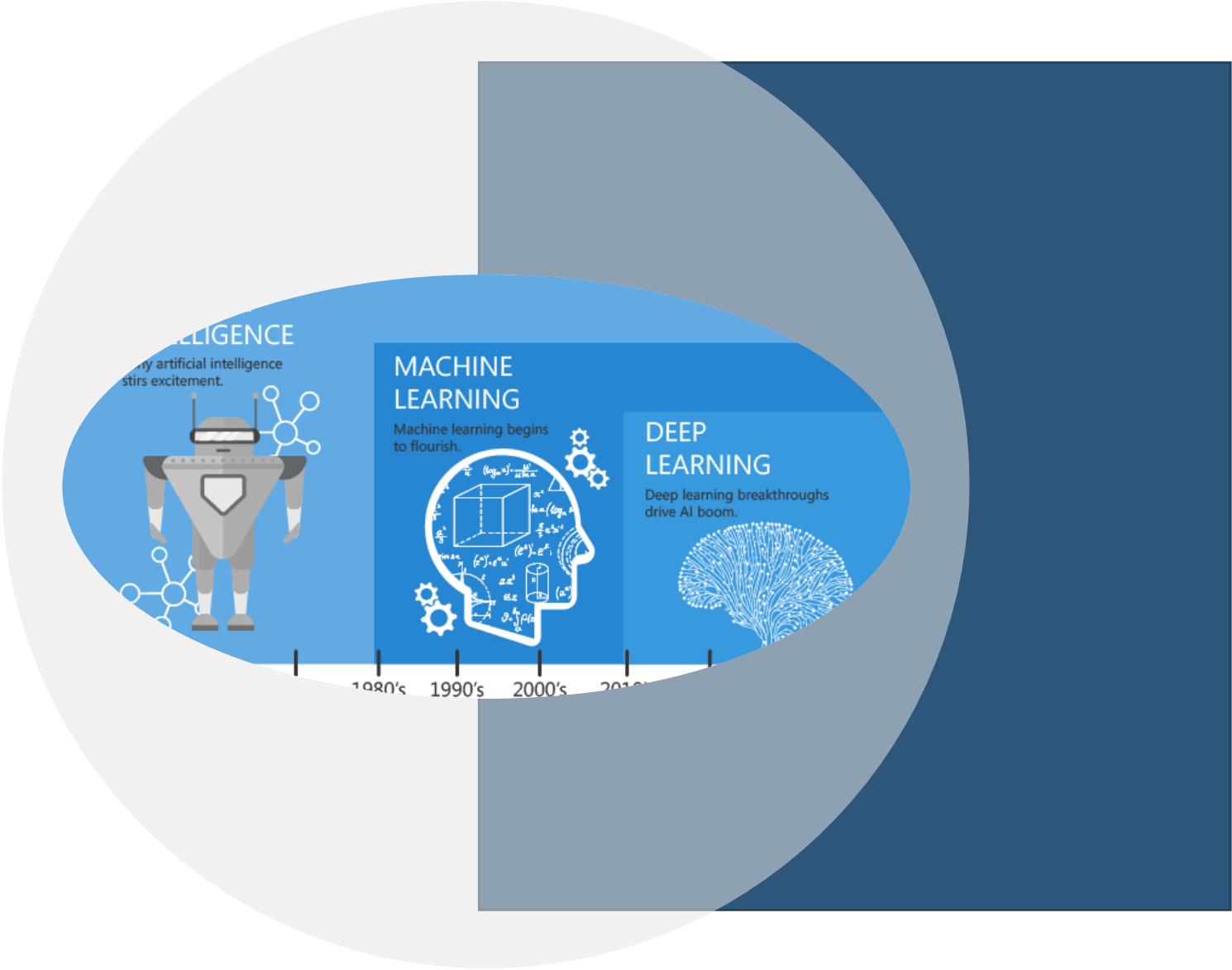


TYPES OF AI

Reactive AI machine is capable of perceiving and analyzing the current scenario and calculating the best action possible at the present time, without any memory of the past. IBM's Deep Blue and Google's AlphaGo are examples of this machine

Limited memory AI machine stores previous data and predictions while making decisions. Various sub-types include reinforced learning, LSTM and E-GAN. One example of limited memory AI machine is a self driving car

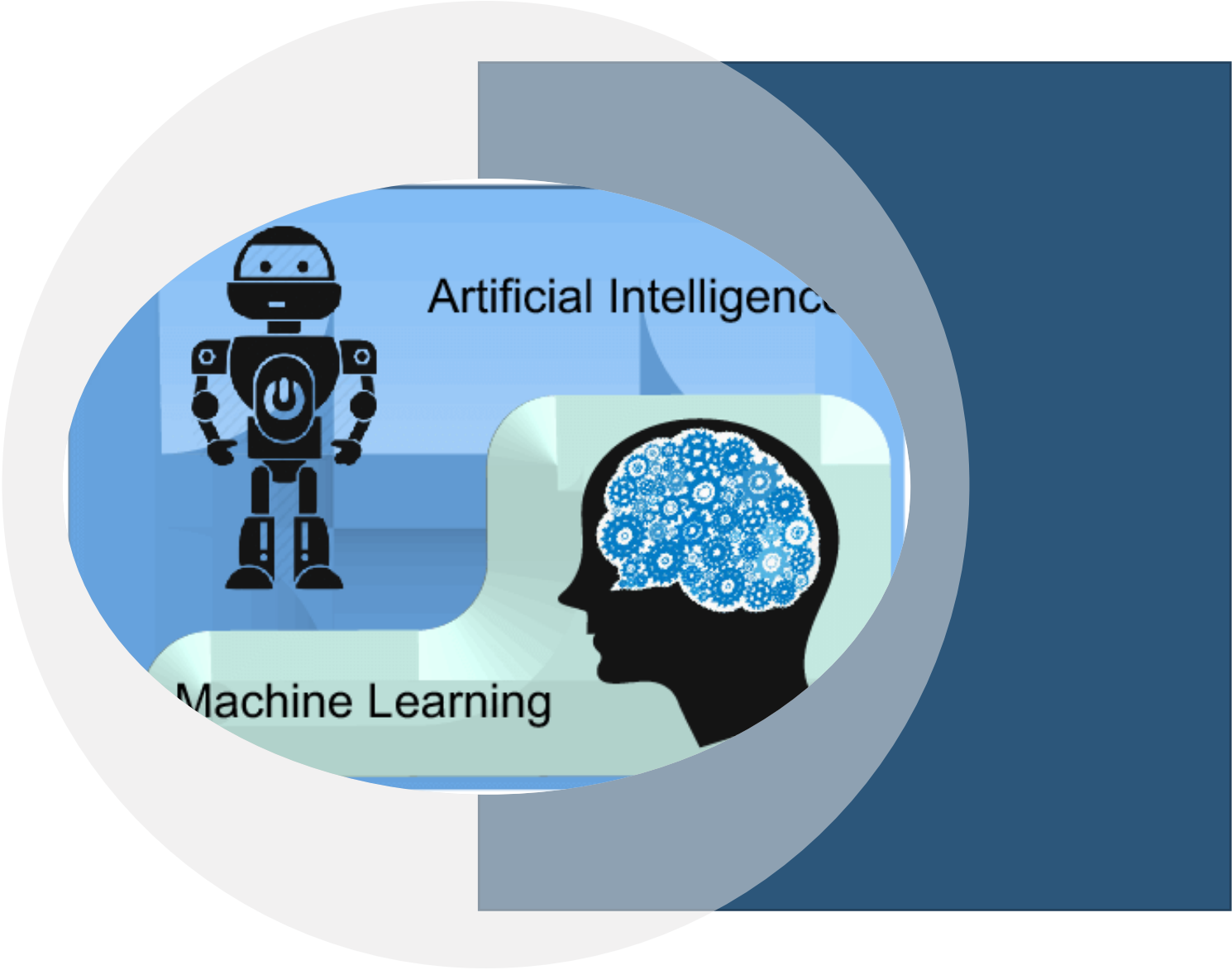
Self driving cars use data collected in the recent past to make immediate decisions.



TYPES OF AI

Theory of Mind AI machine is under development. These machines could comprehend how humans and other living entities feel and make decisions through self-reflection and determination. Using this information, the machine could make its own decisions.

Self Aware AI machine is the ultimate goal of the AI research. It possesses human-level consciousness and understands its own existence in the world, as well as the presence and emotional state of others.



WEAK AND STRONG AI

WEAK ARTIFICIAL INTELLIGENCE

Narrow AI or weak AI is often focused on performing a single task extremely well.

Narrow AI is powered by breakthroughs in machine learning and deep learning.

machine learning feeds a computer data and uses statistical techniques to help it "learn" how to get progressively better at a task

Deep learning is a type of machine learning that runs inputs through a biologically-inspired neural network architecture

STRONG AI OR ARTIFICIAL GENERAL INTELLIGENCE

The AGI machine is with human-level intelligence that can be applied to any task

It is the holy grail for AI researchers

It needs a universal algorithm for learning and acting in any environment

AI APPLICATIONS

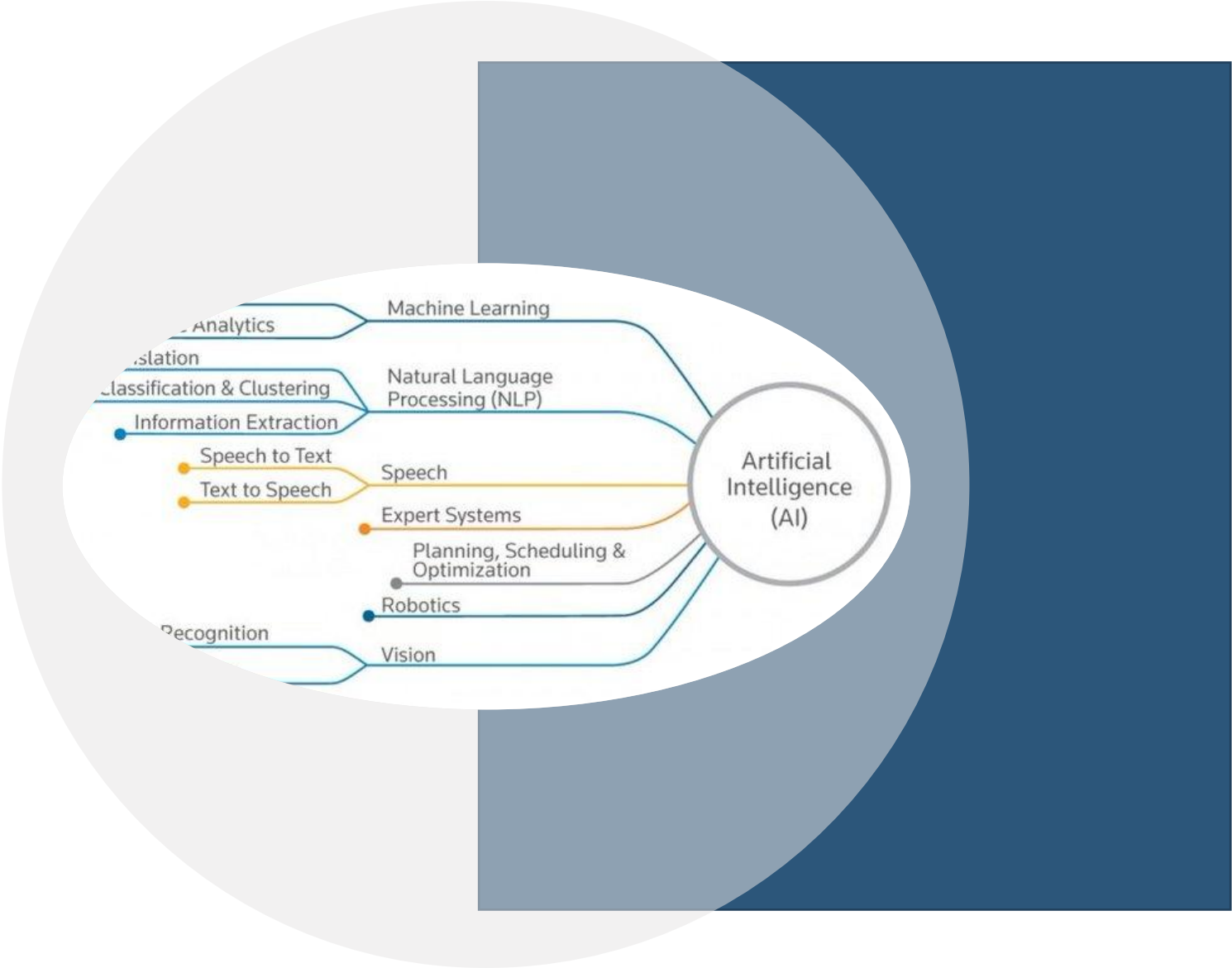
AI applications are as diverse as it gets

There are some broad categories as shown

We see more speech processing applications as Siri, Alexa and Cortana play an increasing role in our computer interactions

AI applications in Robotics and Vision are giving birth to new scenarios such as loading and unloading the trucks by robots

Recently a new robot named Dill was launched that can unload 1600 boxes per hour from a truck



ML FLOW

All of the current AI systems are in the Weak AI category

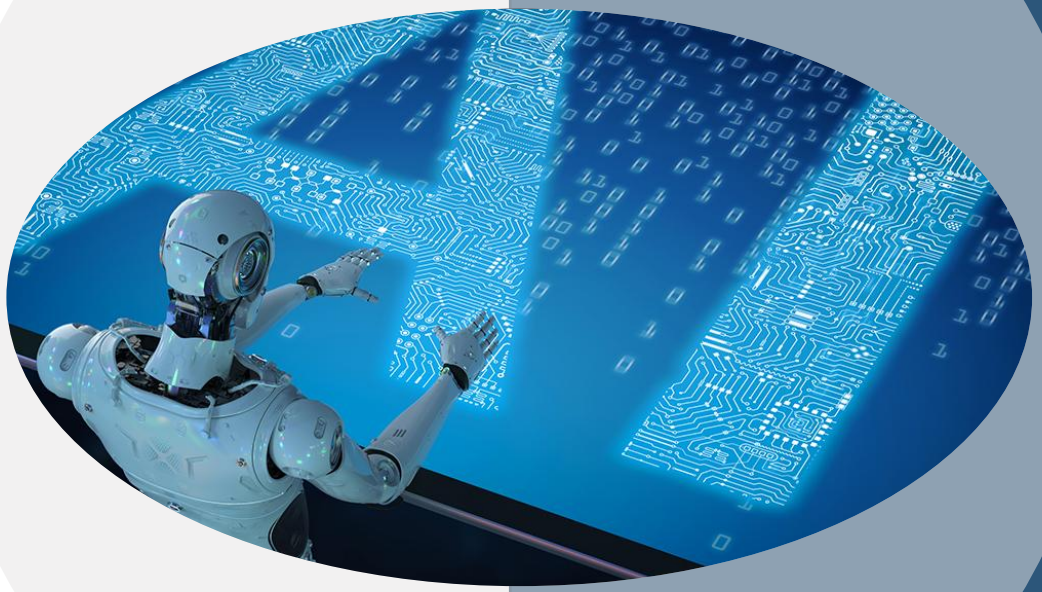
Machine learning and deep learning is increasingly being used in such systems

The ML process starts with getting the data and cleaning it and preparing it

The data is connected with the ML algorithm for training model

It uses mathematical methods to perform predictions based on supervised or unsupervised learning.

Test data is used to improve the predictions

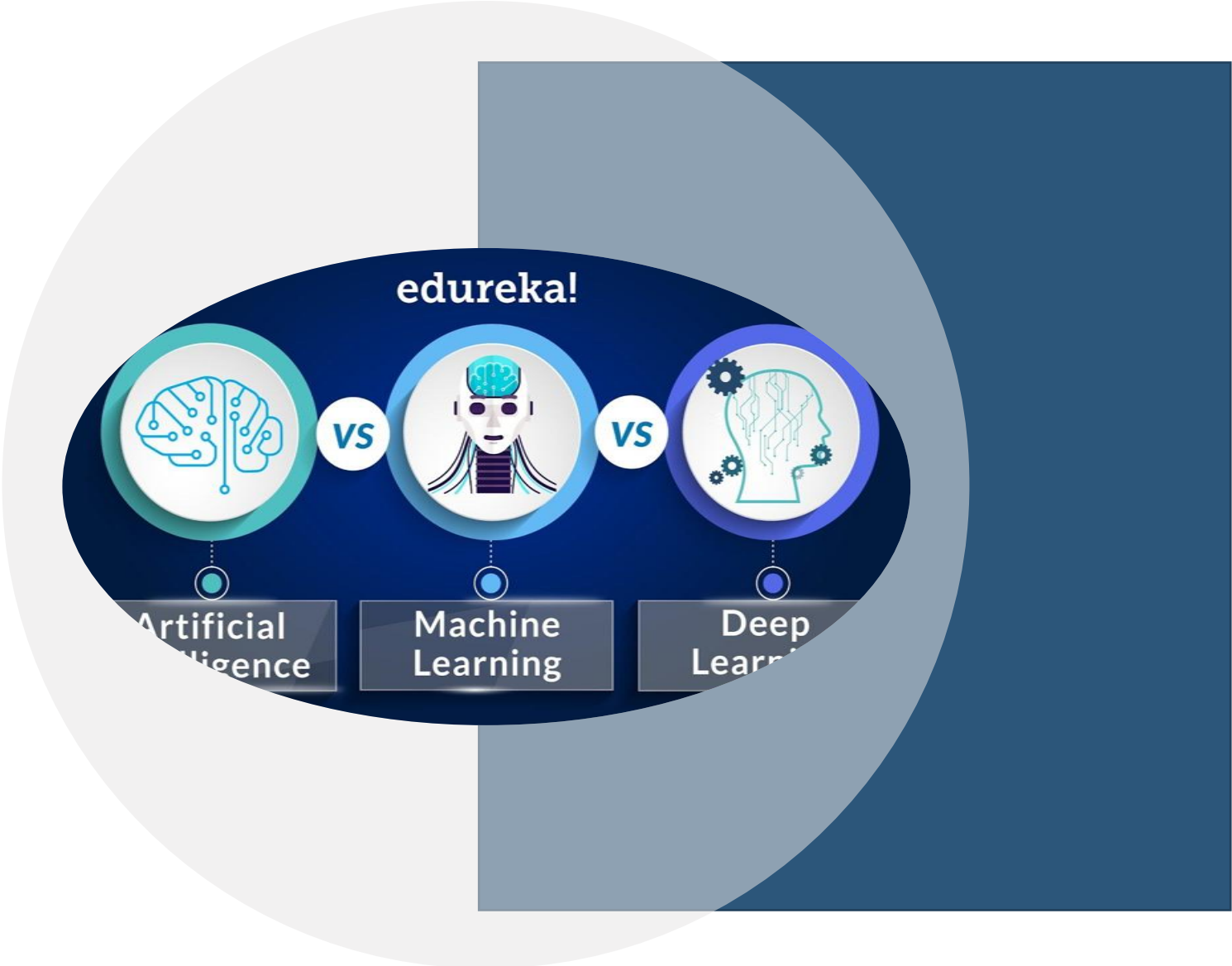


ML FLOW

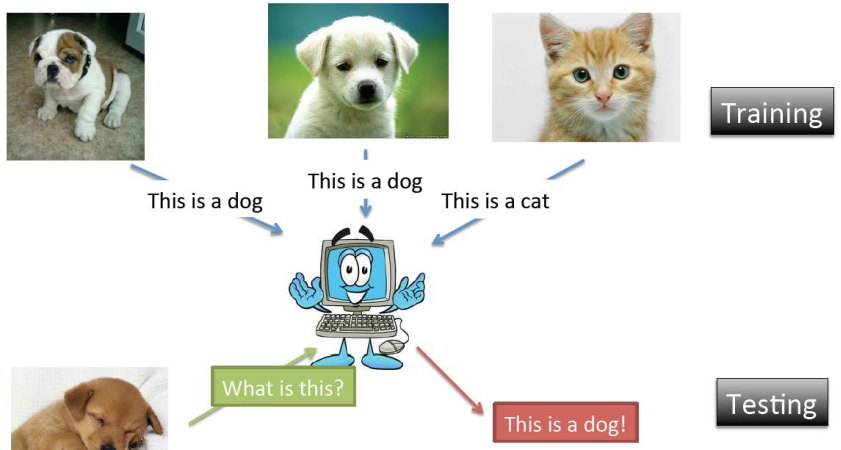
ML performs classification or regression and one can improve the predictions with the training data set and then apply the same on the test data

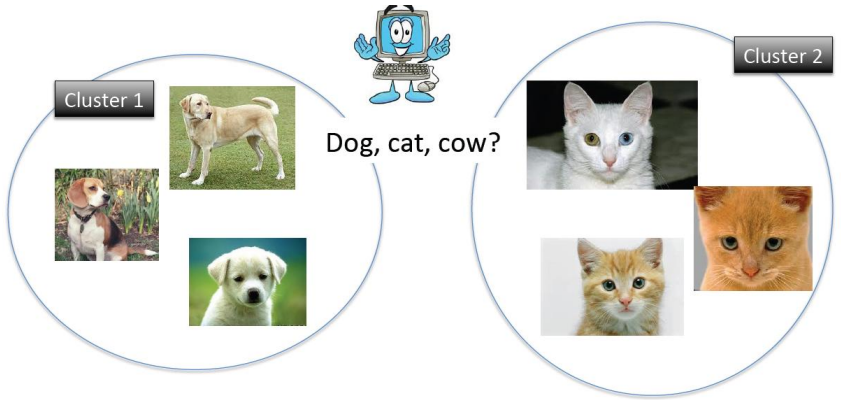
Training: given a training set of labeled examples {(x1,y1), …, (xN,yN)}, estimate the prediction function f by minimizing the prediction error on the training set

Testing: apply f to a never before seen test example x and output the predicted value y = f(x)



ML FLOW



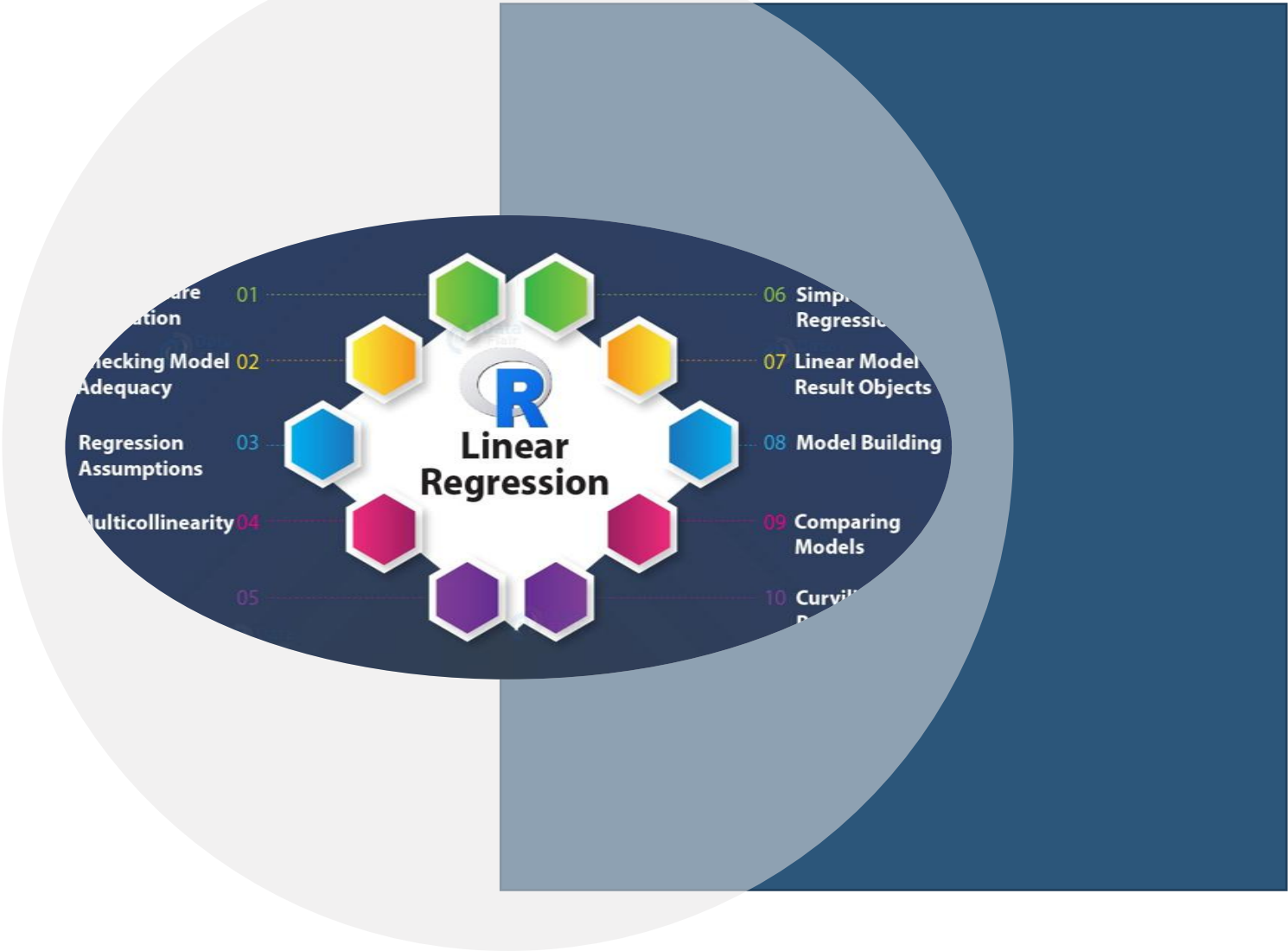


Unsupervised: semantic meanings of clusters are not clear

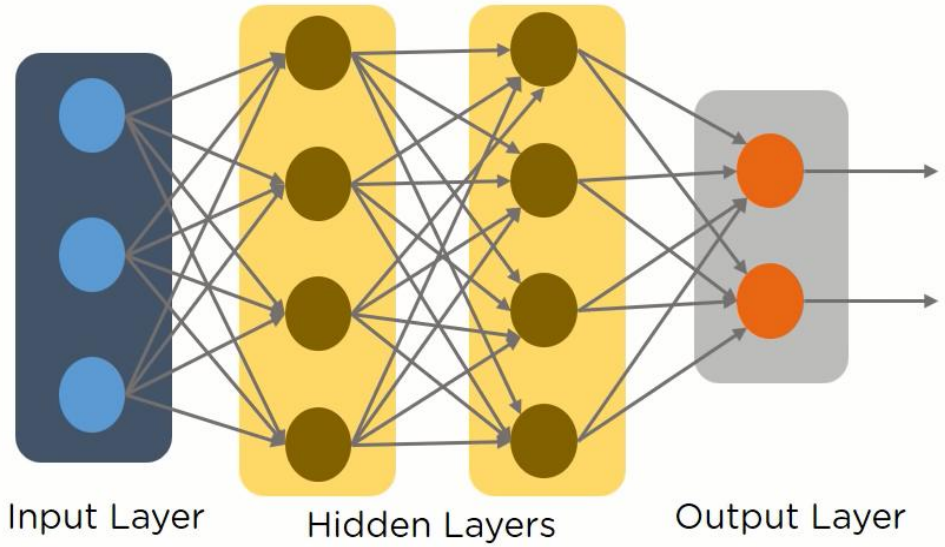
deep learning
vs
machine learning

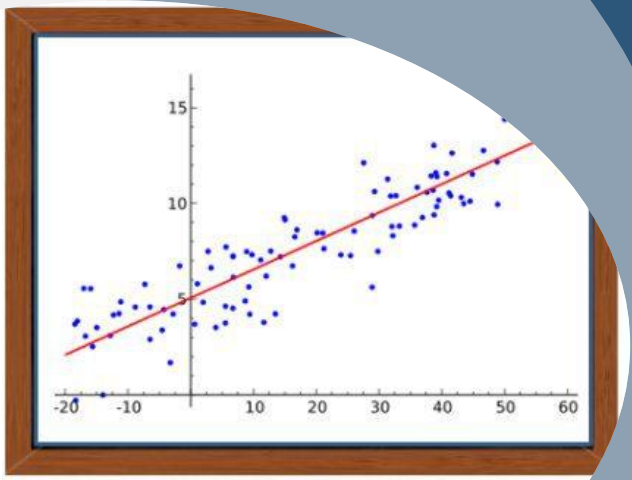
ML FLOW

	Supervised Learning	Unsupervised Learning
Discrete	classification or categorization	clustering
Continuous	regression	dimensionality reduction



ANN AND DL





ANN is constructed with input, hidden and output layers as a specific case of ML.

When the number of hidden layers increases to 2 or more, machine learning name is changed to deep learning

UNSUPERVISED AND SUPERVISED LEARNING

UNSUPERVISED LEARNING

K-means clustering

Agglomerative clustering

Mean-shift clustering

Spectral clustering

Support Vector Machine

Neural networks

Naïve Bayes

Bayesian network

Logistic regression

Randomized Forests

Boosted Decision Trees

K-nearest neighbor

RBMs (Restricted Boltzmann machine, a type of ANN)

SUPERVISED LEARNING

TOOLS TO USE

R is an open source system for statistical computation and graphics.

R provides support for data mining applications

It is an interpreted language

Keras for R allows data scientists to run deep learning models in an R interface. Coupled with Torch, it offers great flexibility

Keras team announced a new version of Deep Learning for R, with updated functionality and architecture

ML AND PYTHON

PYTHON CHARACTERISTICS

Python is the most popular language for machine learning and AI applications

It is an object oriented interpreter based language

Several libraries are available in Python for data science and machine learning applications

NumPy

SciPy

Pandas

SciKit-Learn

Matplotlib and Seaborn for visualization

PYTHON LIBRARIES

NumPy: introduces objects for multidimensional arrays and matrices and advanced mathematical and statistical operations on those objects

SciPy (built on Numpy): collection of algorithms for linear algebra, differential equations, numerical integration, optimization and statistics

Pandas: adds data structures and tools designed to work with table-like data and provides tools for data manipulation such as reshaping, merging, sorting, slicing and aggregation

SciKit-Learn: provides machine learning algorithms for classification, regression, clustering, model validation etc. built on NumPy, SciPy and matplotlib

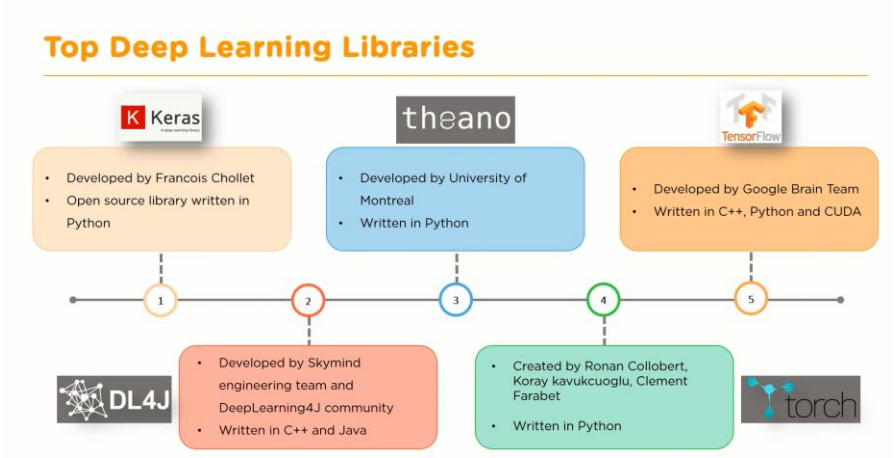
Matplotlib: Visualization including scatterplots, bar charts and histograms

TENSORFLOW

Tensorflow is an open source platform for ML and DL by Google brain team. It was written in C++, Python and CUDA

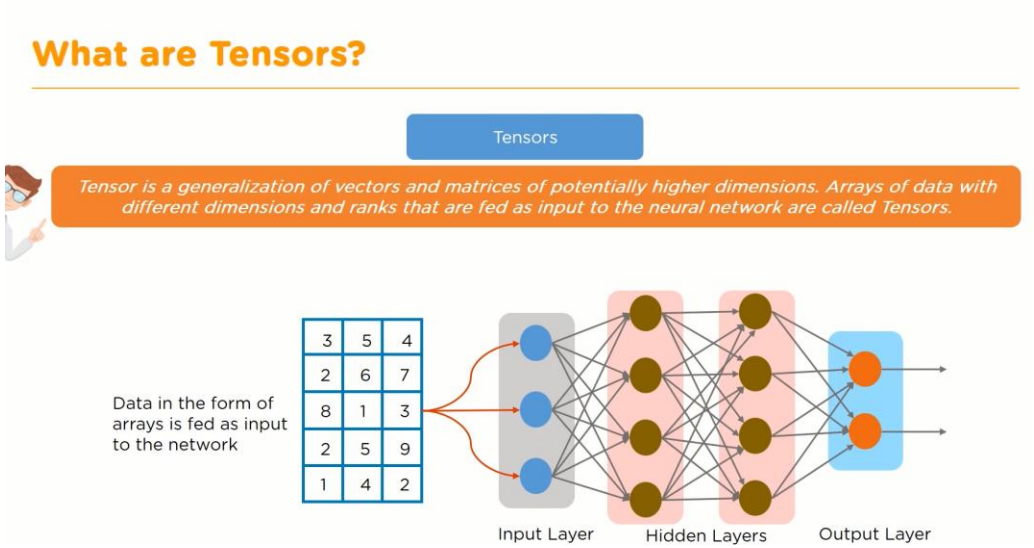
TensorFlow defines Tensors as multidimensional arrays

It can leverage the high performance computing power of GPU's, thus accelerating deep learning applications



TENSORFLOW EXPLAINED

TENSOR DEFINITION



WHAT IS A TENSOR RANK?

MORE AI TOOLS AND FRAMEWORKS

Caffe, for AI computer vision applications, was developed at UC Berkeley

Caffe2, a follow-up to Caffe, was developed at Facebook. With new Open Neural Network Exchange (ONNX) format, converting trained PyTorch network to Caffe2 for inference is fairly straightforward

The Microsoft Cognitive Tool Kit (**CNTK**) is an AI framework developed by Microsoft, primarily for speech and NLP applications

MXNET, a flexible framework for cloud, is suitable for AWS deployment

PyTorch from Facebook is well suited for NLP

HEALTHCARE APPLICATIONS

Many applications of AI and ML are emerging in a diverse set of fields

In healthcare, some examples

Diagnosing diabetic eye disease using deep learning

Detecting anemia from retinal fundus images using deep learning

Predicting cardiovascular risk factors from retinal fundus photographs using deep learning

Predicting osteoarthritis using machine learning

SMART CITY APPLICATIONS

In smart city, AI applications include

Security cameras that detect criminal activity in real-time and alert the authorities

Road condition monitoring and repair planning

Predicting future energy and housing needs

Monitor and cut pollution

Parking space recommendation and enforcement

Urban transport planning and scheduling based on expected usage

Waste management and collection improvement

OUR CONTRIBUTIONS

I have worked with a colleague in NUST Islamabad to propose a network of smart dumpsters in Islamabad. As the waste level in each dumpster is communicated to the central computer, optimization algorithms determine the schedule and dispatch of trucks for collection

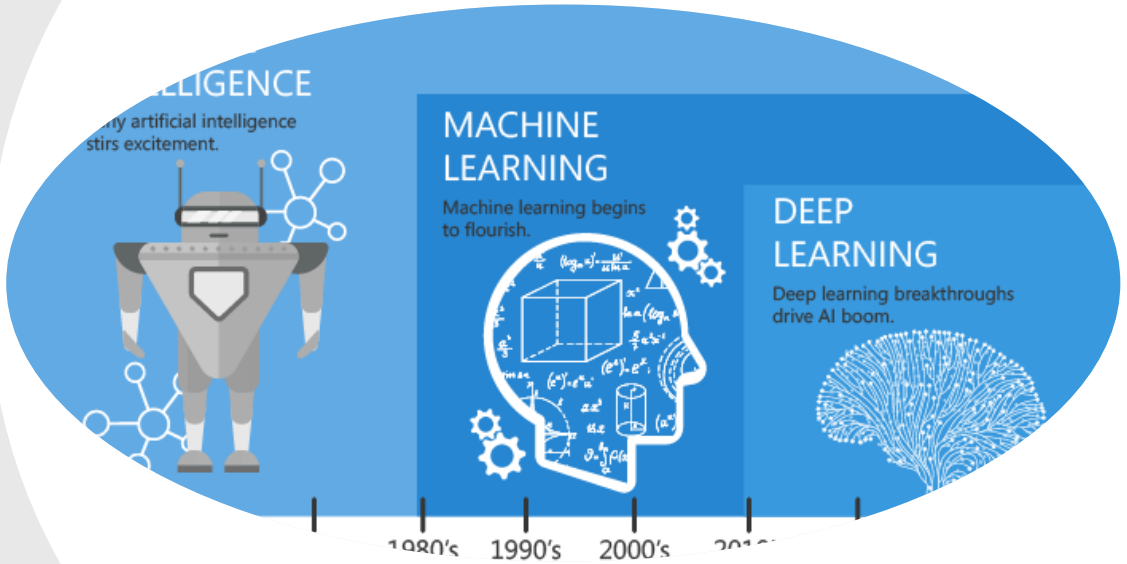
I. Mahmood and J. Zubairi, *"Enabling Internet of Things Based Waste Management and Recycling in Smart Cities"*, IEEE Electrification Magazine September 2019, Pages 33-43.

OUR CONTRIBUTIONS

I am currently leading a research group on smart city and IoT applications

Currently we are working on a project on smart city PROACTIVE traffic management with machine learning. Our ultimate goal is to use ML to guide the drivers away from potential congestion points so that the urban grid of streets never experiences congestion

Based on the historical data and the current conditions, ML algorithms will predict the expected congested road segments and remedial measures will be taken to avoid congestion



THANK YOU

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