BSC~Microsoft Research Centre

Programming and Artificial Intelligence

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UCERD Pvt Ltd Islamabad

IEEE

Unal Center of Education Research and Development

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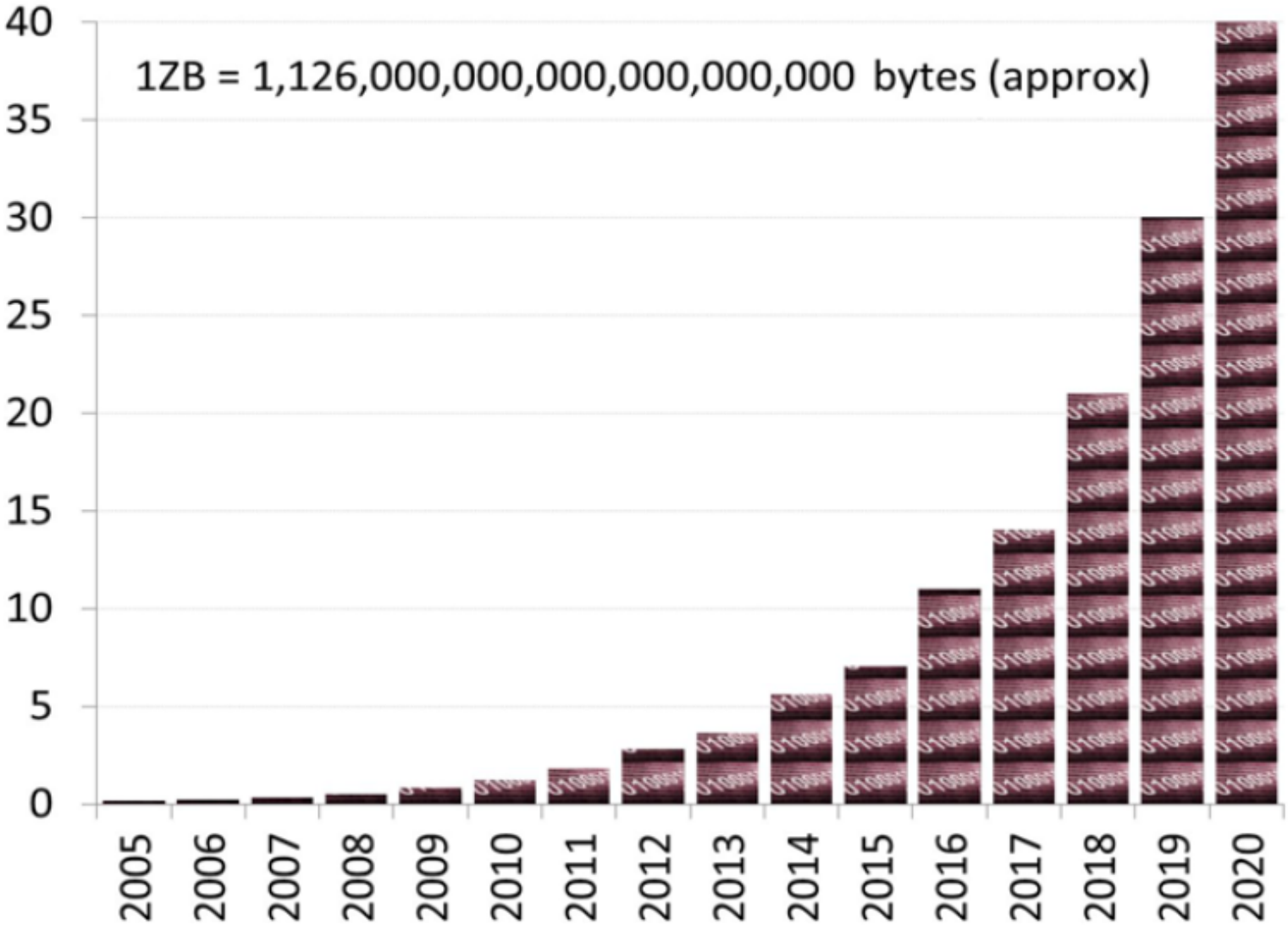
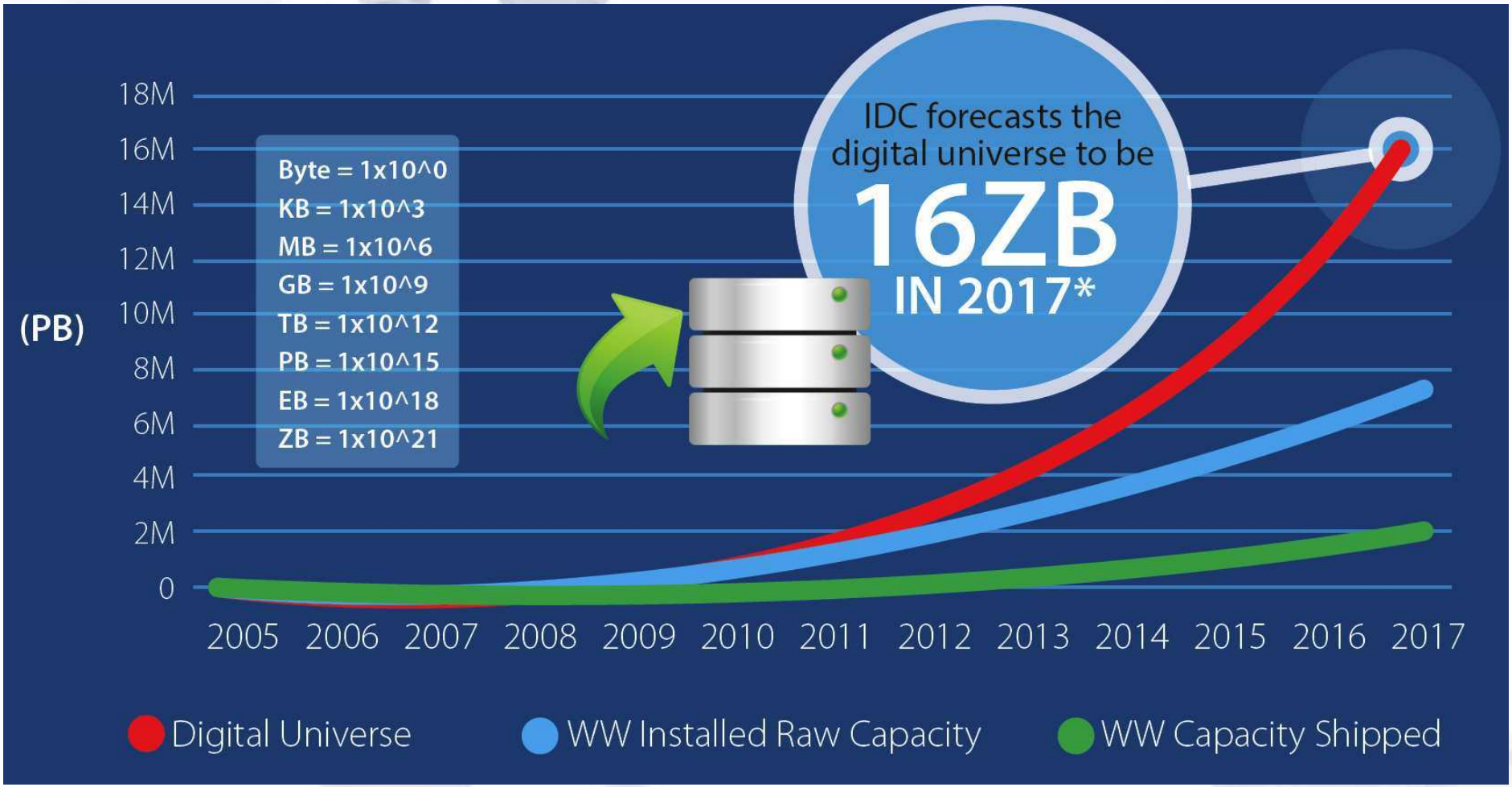
All Global Data in Zettabytes



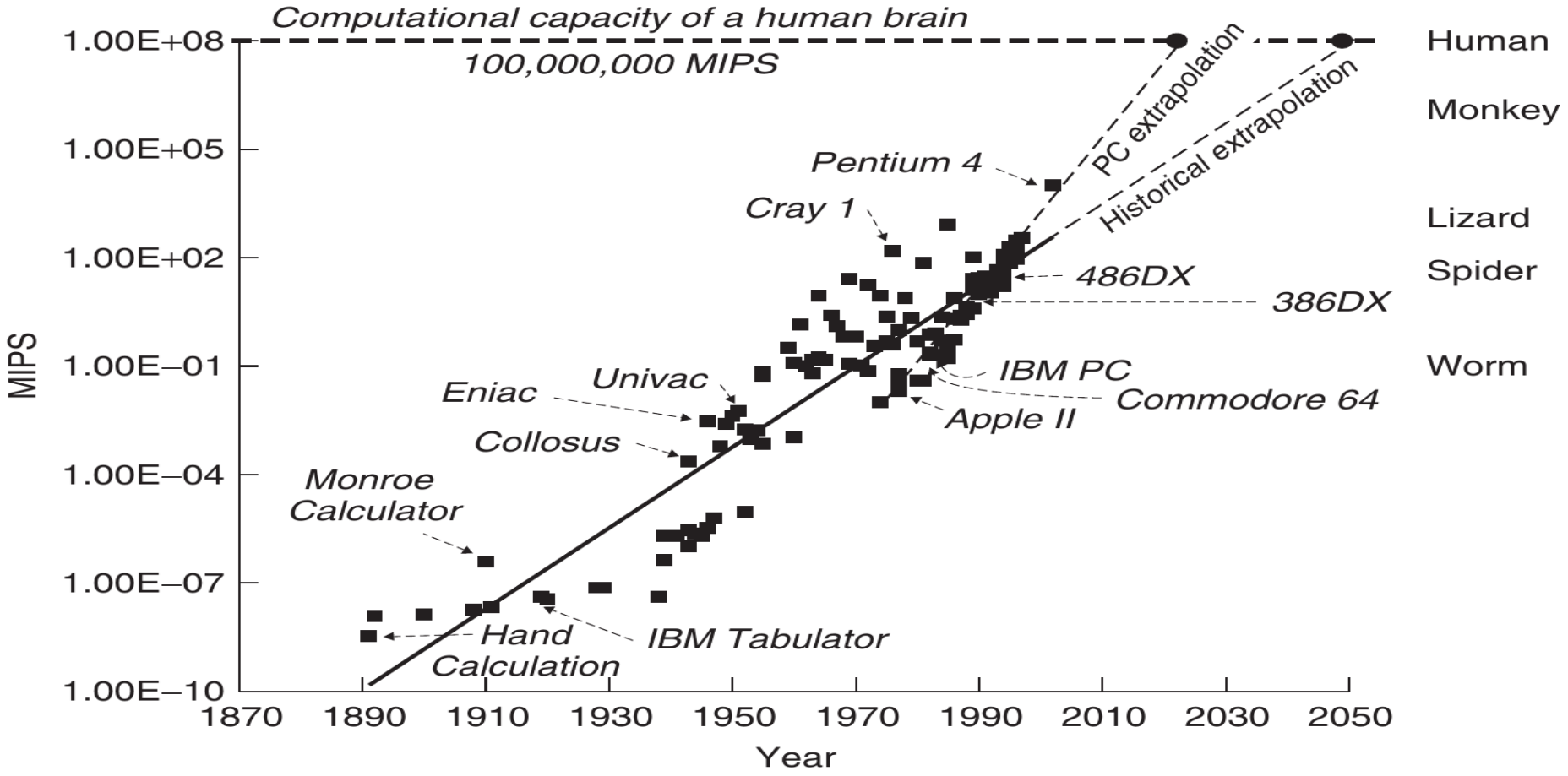
Source: **http://www1.unece.org/stat/platform/display/msis/Big+Data**

Information Future Trend



Technology Research Gartner Inc. states that information data volume doubles after every 18 months.

Computational Capability



It is estimated that sometime between the years **2025 and 2050**, a **personal computers** will exceed the calculation power of a human brain.

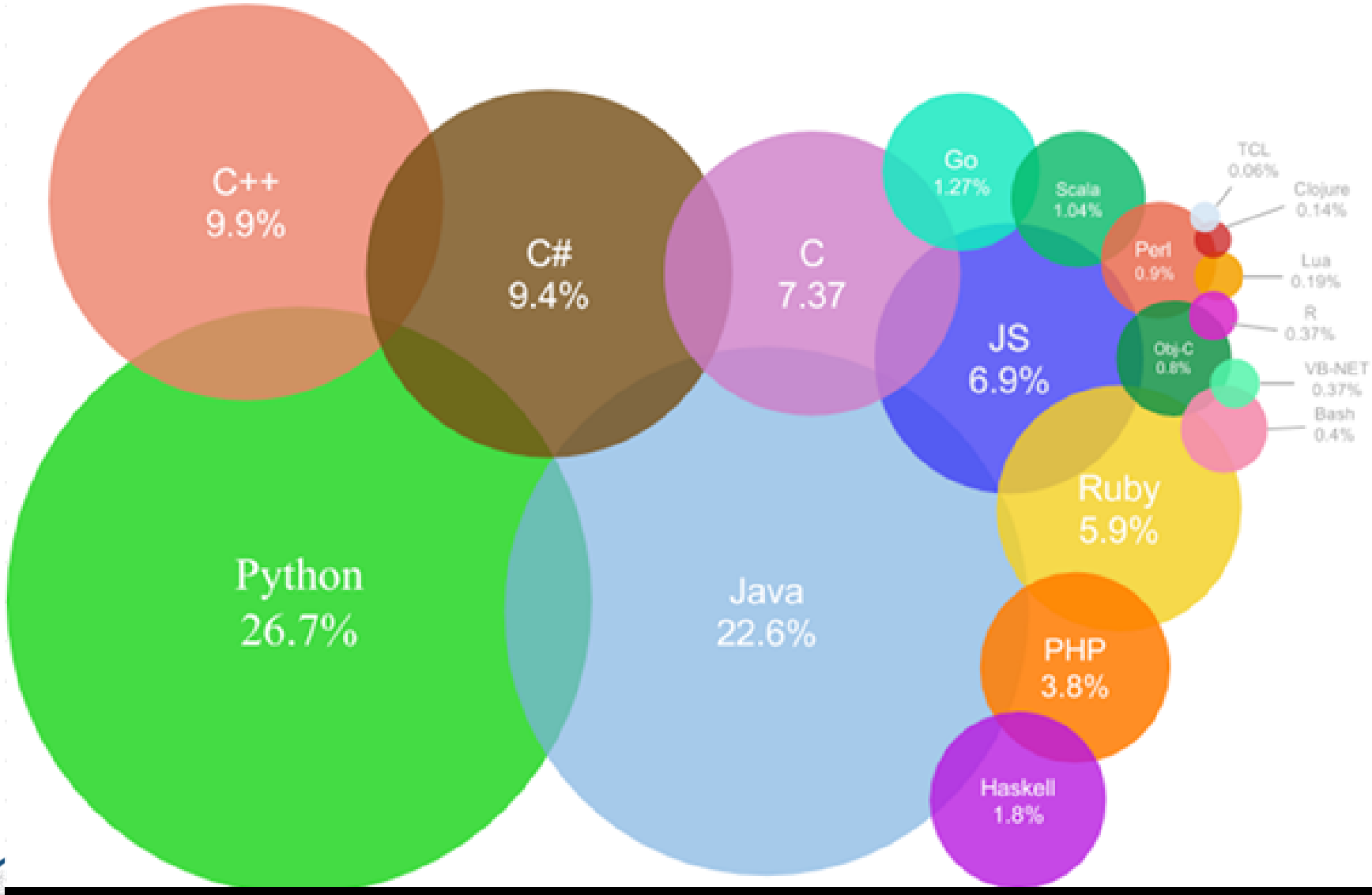
RIPHAH INTERNATIONAL UNIVERSITY

Coding Languages

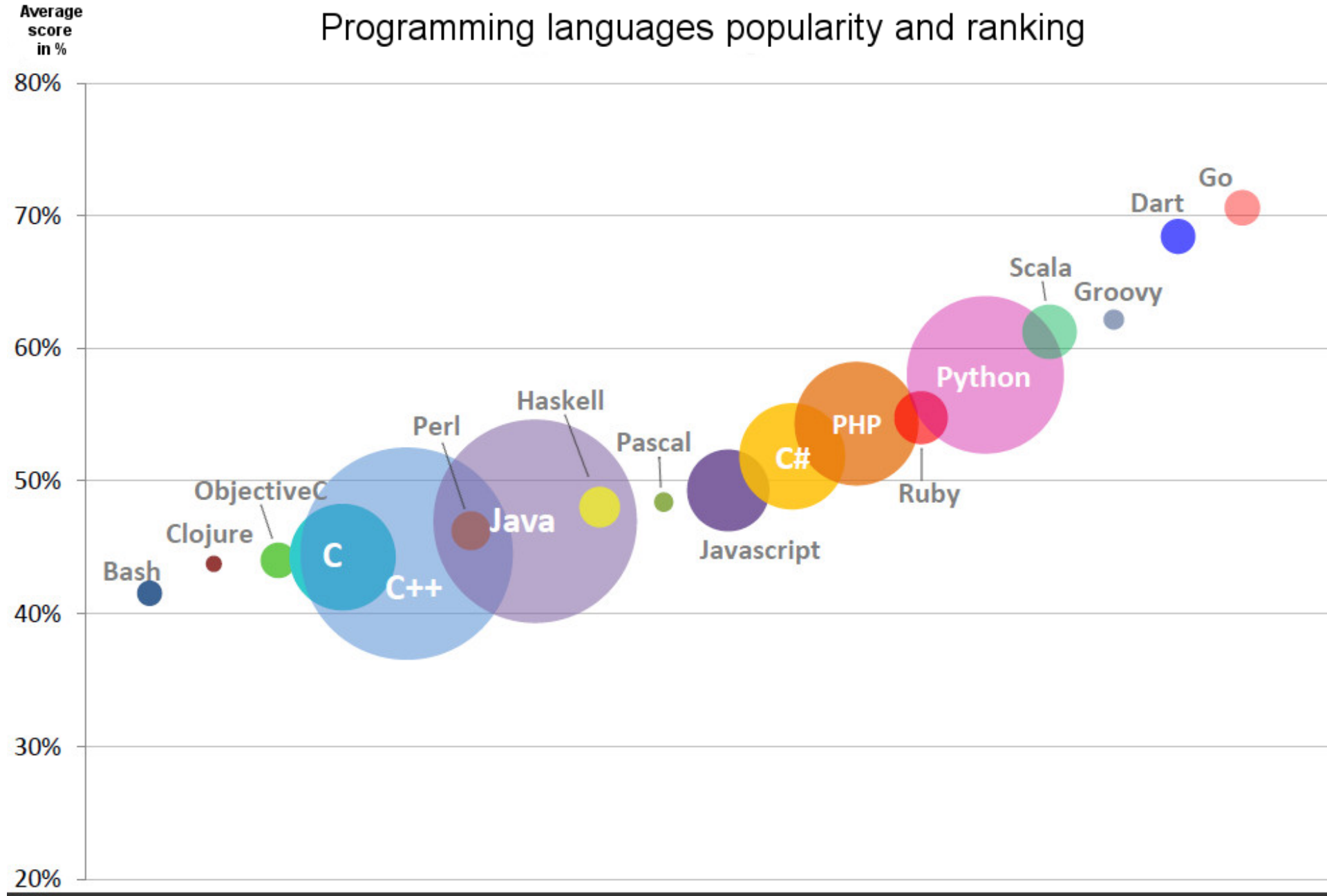
Programming Languages

Scripting Languages

Most Popular Coding Languages of 2016

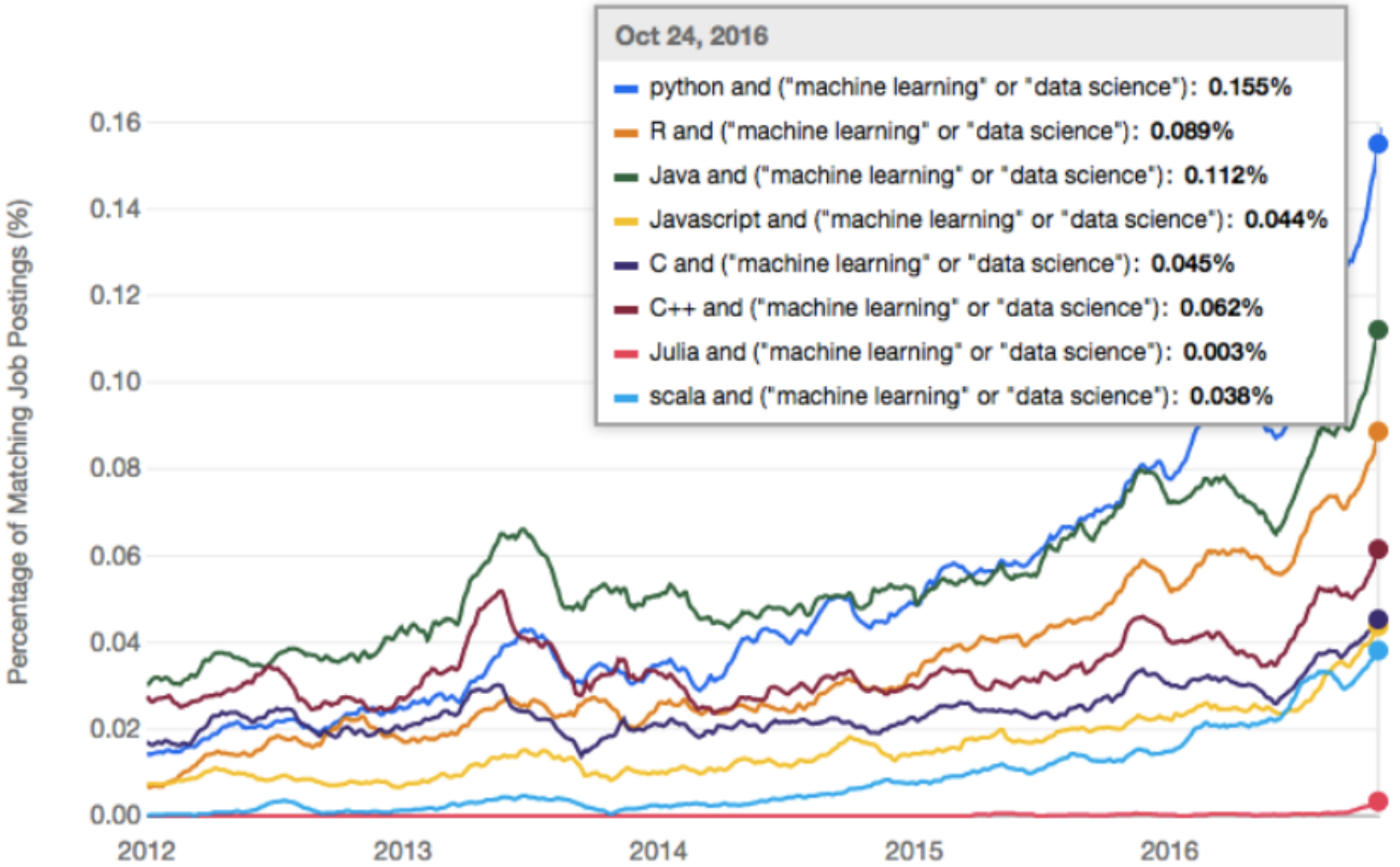


Programming languages popularity and ranking



Based on the most used programming languages in the coding contests of the first half of 2014

CodinGame


Oct 24, 2016
python and ("machine learning" or "data science"): 0.155%
R and ("machine learning" or "data science"): 0.089%
Java and ("machine learning" or "data science"): 0.112%
Javascript and ("machine learning" or "data science"): 0.044%
C and ("machine learning" or "data science"): 0.045%
C++ and ("machine learning" or "data science"): 0.062%
Julia and ("machine learning" or "data science"): 0.003%
scala and ("machine learning" or "data science"): 0.038%
Percentage of Matching Job Postings (%)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
2012
2013
2014
2015
2016

Executing a Program on HPC System

1. If you are starting with an existing serial program, debug the serial code completely
2. Identify the parts of the program that can be executed concurrently:
   - Requires a thorough understanding of the algorithm
   - Exploit any inherent parallelism which may exist.
   - May require restructuring of the program and/or algorithm. May require an entirely new algorithm.
3. Decompose the program:
   - Functional Parallelism
   - Data Parallelism
   - Combination of both
4. Code development
   - Code may be influenced/determined by machine architecture
   - Choose a programming paradigm
   - Determine communication
   - Add code to accomplish task control and communications
5. Compile, Test, Debug
6. Optimization
   - Measure Performance
   - Locate Problem Areas
   - Improve them

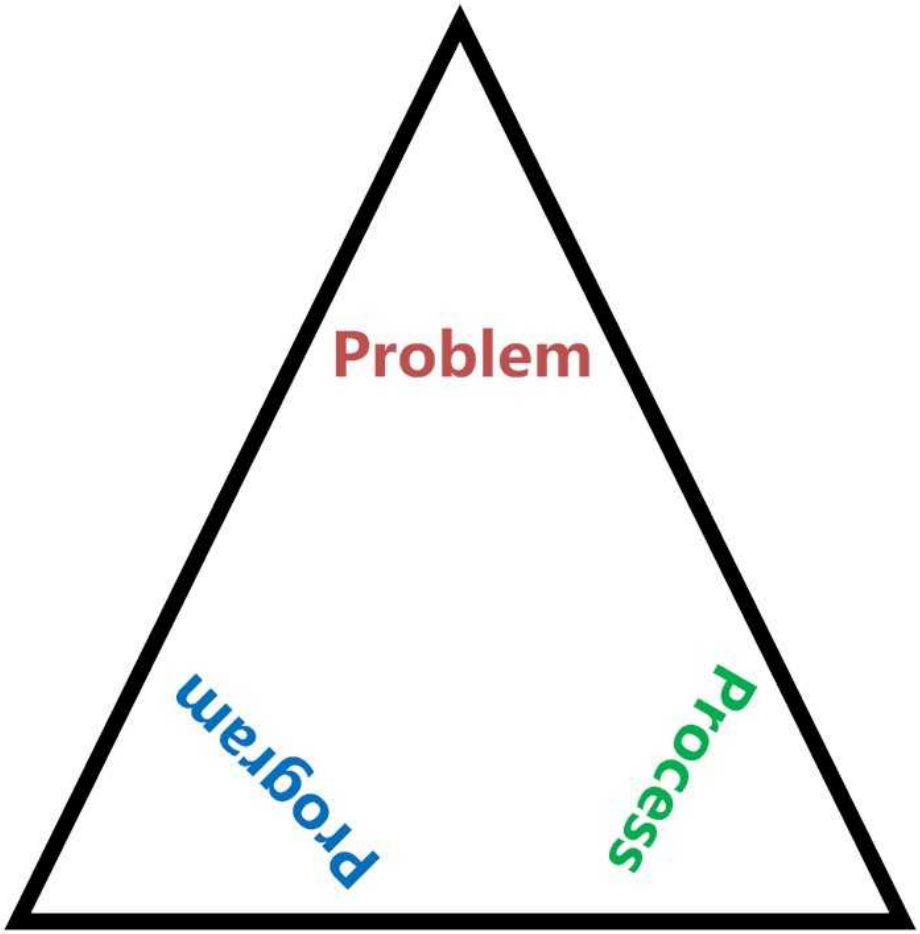
Types of Parallelism

Instruction Level Parallelism
Task Level Parallelism
Data Level Parallelism

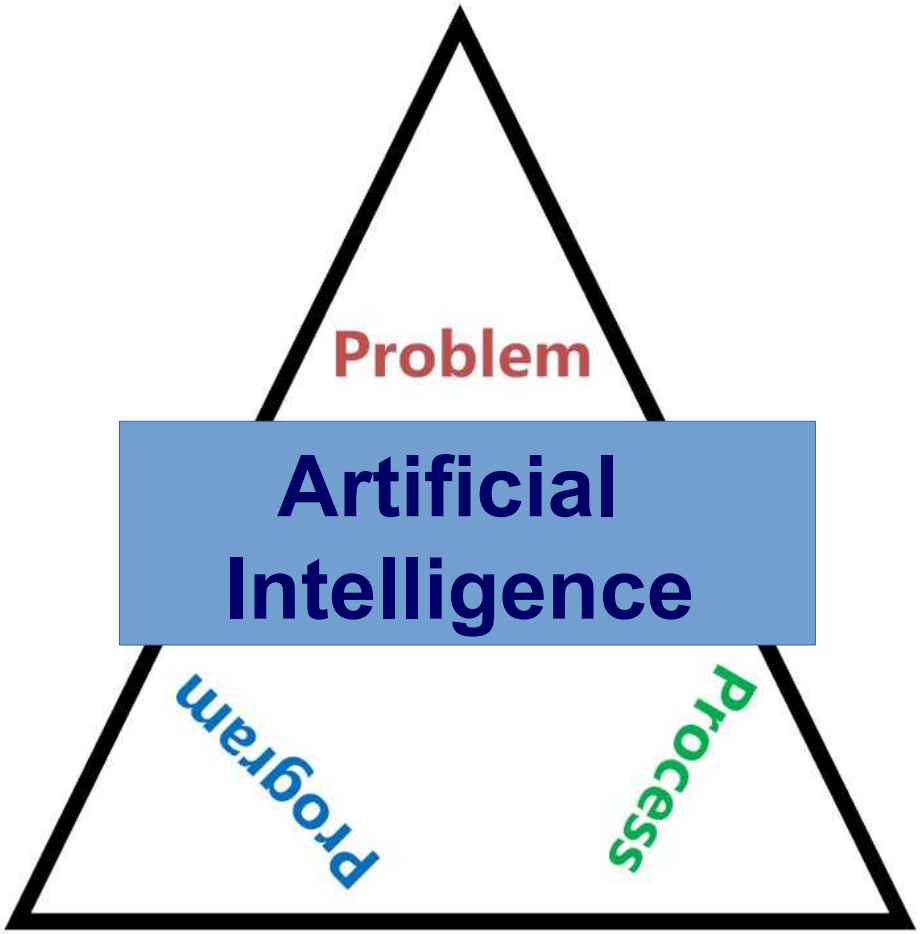
Parallel Programmings

- C++
  - Pthread Libraries
- Parallel Programming Models
  - OpenMP
  - MPI
  - OpenACC
  - OpenCL

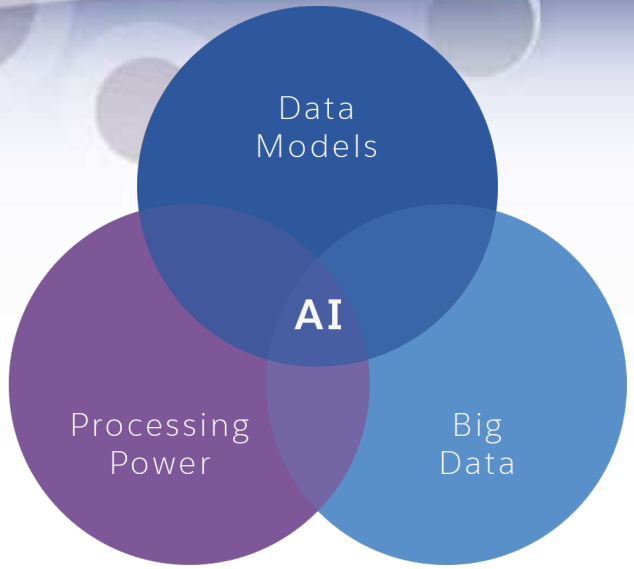
Problem Program and Process



Problem Program and Process



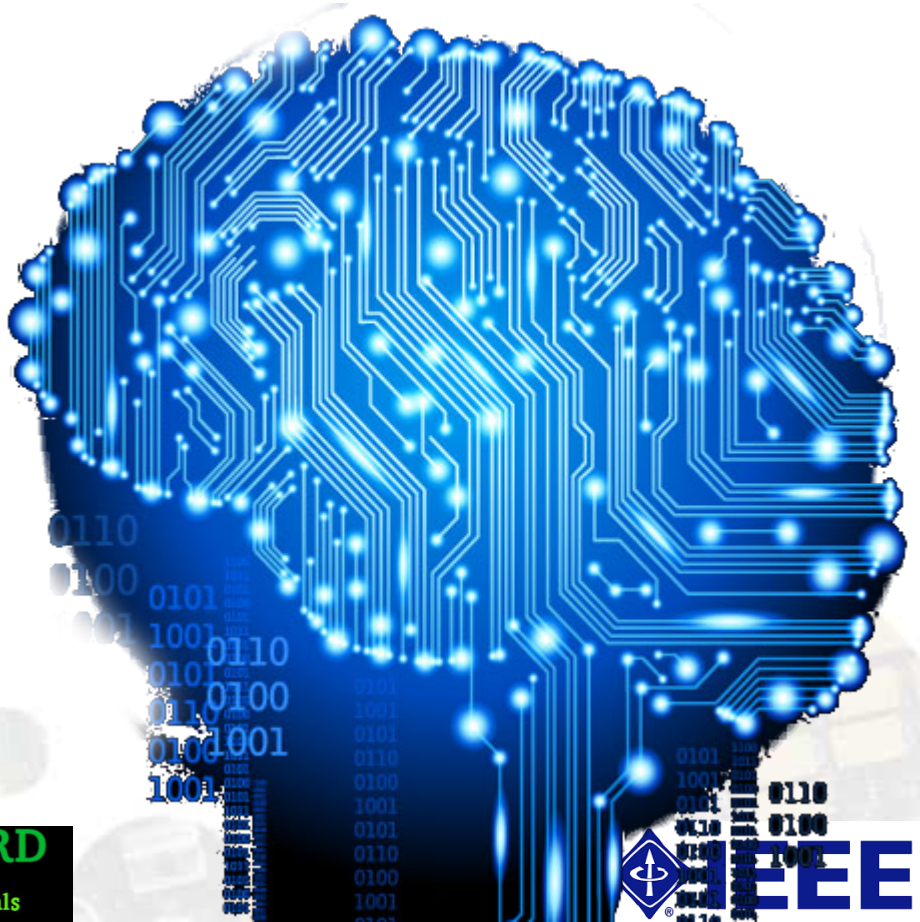
Artificial Intelligence



The theory and development of computer systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.

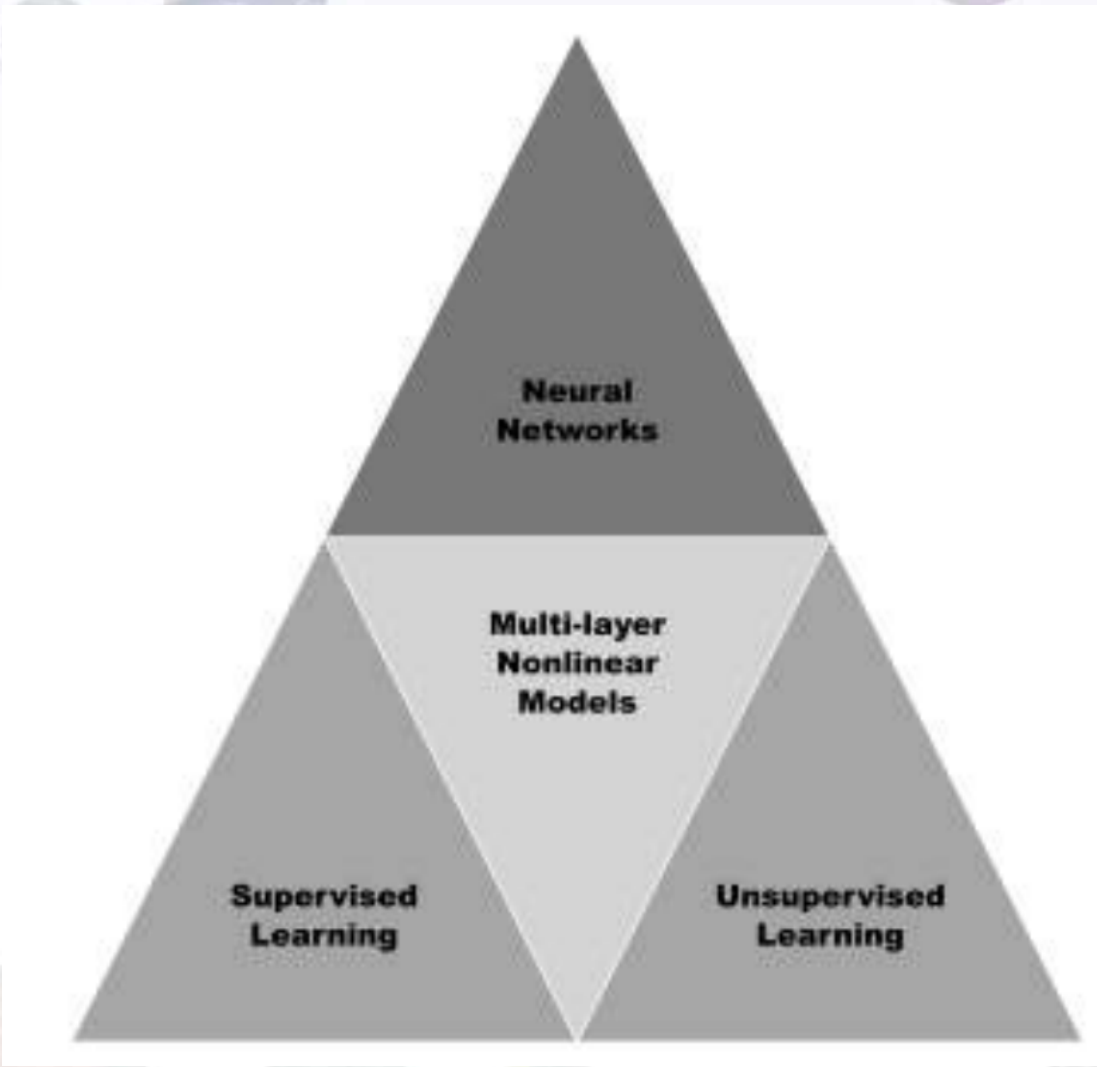
Artificial Intelligence

- Inspired by the brain
  - Input Data
  - Memorize
  - Process
  - Learn
  - Decision



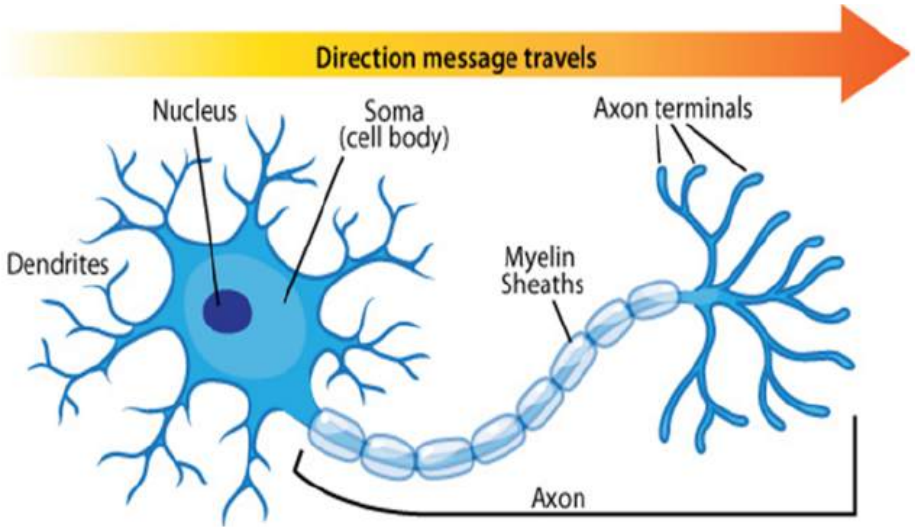
Types of Learning

- **Supervised learning:** Your training data contain the known outcomes. The model is trained relative to these outcomes.
- **Unsupervised learning:** Your training data does not contain any known outcomes. In this case the algorithm self-discovers relationships in your data.
- **Reinforcement Learning**: This type of learning focus on the end outcome to learn e.g. chess. The learning does not have any labeled data or action. It generates the labels based on success or failure of action.


Neural Networks
Multi-layer Nonlinear Models
Supervised Learning
Unsupervised Learning

Biological Neuron

- A Biological neurons pass signals or messages to each other via electrical signals.
- Neighboring neurons receive these signals through their dendrites.
- Information flows from the dendrites to the main cell body, known as the soma, and via the axon to the axon terminals.
- In essence, biological neurons are computation machines passing messages between each other about various biological functions.
- At the heart of an artificial neural network is a mathematical node, unit or neuron. It is the basic processing element.

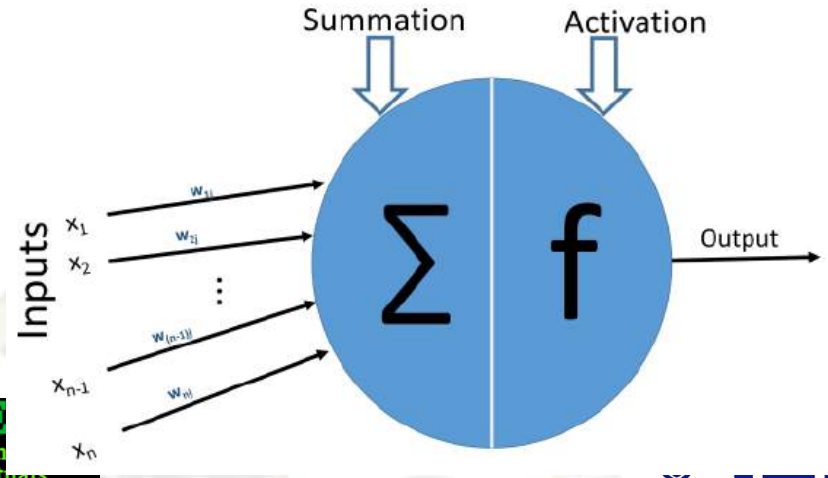


Workings of an individual neuron

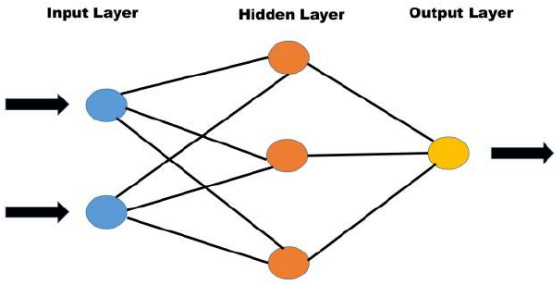
- Given a sample of input attributes {x1 ,...,xn} a weight wij is associated with each connection into the neuron; and the neuron then sums all inputs according to:

$$f(u) = \sum_{i=1}^{n} w_{ij} x_j + b_j$$

- The parameter bj is known as the bias and is similar to the intercept in a linear regression model. It allows the network to shift the activation function “upwards” or “downwards”.



- In their simplest form, feed-forward neural networks propagate attribute information through the network to make a prediction, whose output is either continuous for regression or discrete for classification.



- Illustrates a typical feed forward neural network topology. It has 2 input nodes, 1 hidden layer with 3 nodes, and 1 output node. The information is fed forward from the input attributes to the hidden layers and then to the output nodes which provide the classification prediction. It is called a feed forward neural network because the information flows forward through the network.

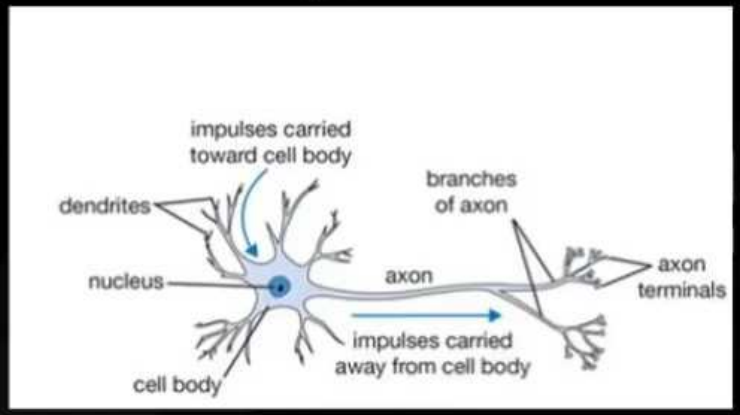
Neural Network

- A Neural network is constructed from a number of interconnected nodes known as neurons. These are usually arranged into a number of layers.
- A typical feed forward neural network will have at a minimum an input layer, a hidden layer and an output layer.
- The input layer nodes correspond to the number of features or attributes you wish to feed into the neural network.
- These are akin to the co-variates to use in a linear regression model.
- The number of output nodes correspond to the number of items you wish to predict or classify.
- The hidden layer nodes are generally used to perform non-linear transformation on the original input attributes.

AN: Artificial Neuron

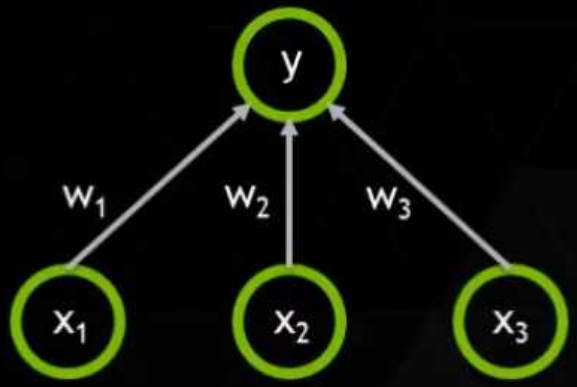
A collection of simple, trainable mathematical units that collectively learn complex functions

Biological neuron



From Stanford cs231n lecture notes

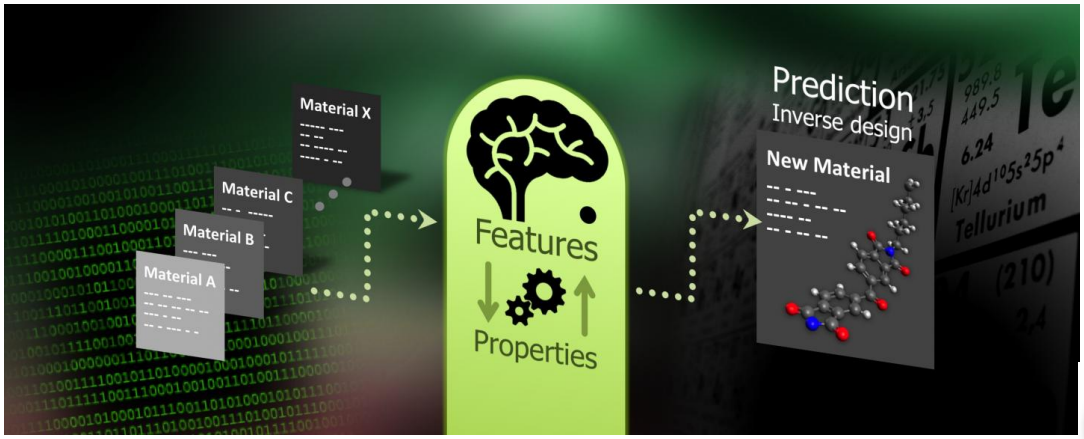
Artificial neuron

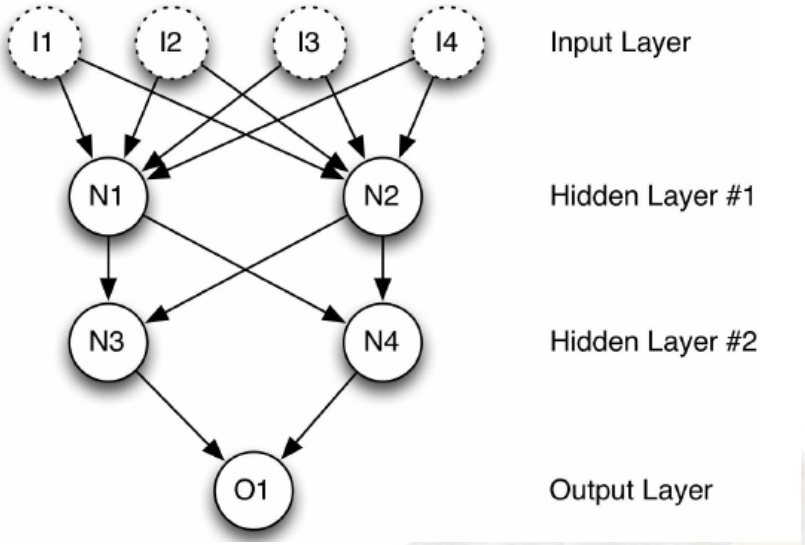


$y=F(w_1x_1+w_2x_2+w_3x_3)$

$F(x)=\max(0,x)$

NN: Neural Networks

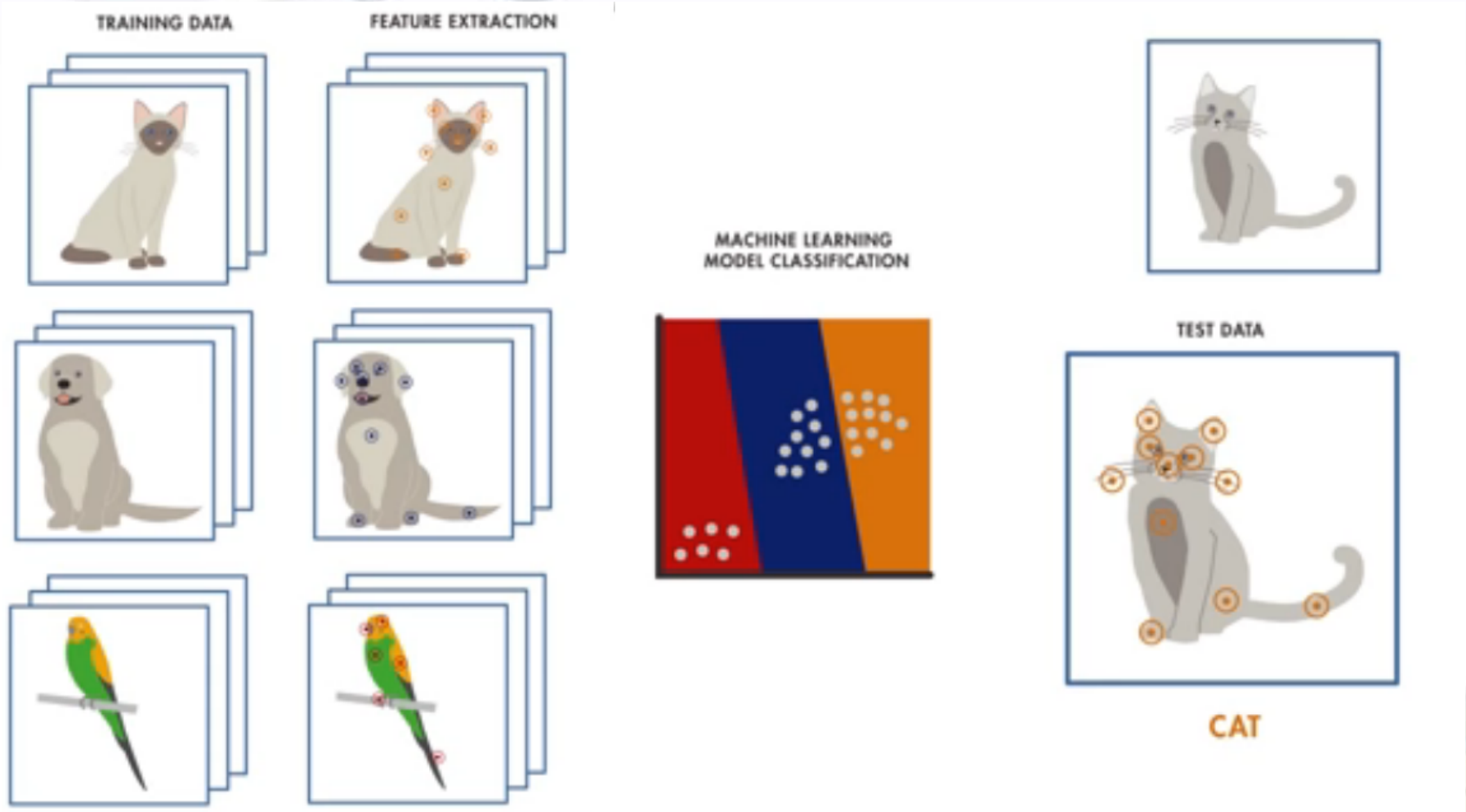




Machine and Deep Learning

Bother offers ways to train models and classify data.

Machine and Deep Learning



Steps

- Define Problem.
- Prepare Data.
- Evaluate Algorithms.
- Improve Results.
- Present Results.

Machine Learning

- Installing the Python and SciPy platform.
- Loading the dataset.
- Summarizing the dataset.
- Visualizing the dataset.
- Evaluating some algorithms.
- Making some predictions.

Import libraries

```
# Load libraries
import pandas
from pandas.tools.plotting import scatter_matrix
import matplotlib.pyplot as plt
from sklearn import model_selection
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
from sklearn.metrics import accuracy_score
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.discriminant_analysis import LinearDiscriminantAnalysis
from sklearn.naive_bayes import GaussianNB
from sklearn.svm import SVC
```

Load Dataset

Summarize the Dataset

Dimensions of the dataset.

Peek at the data itself.

Statistical summary of all attributes.

Breakdown of the data by the class variable.

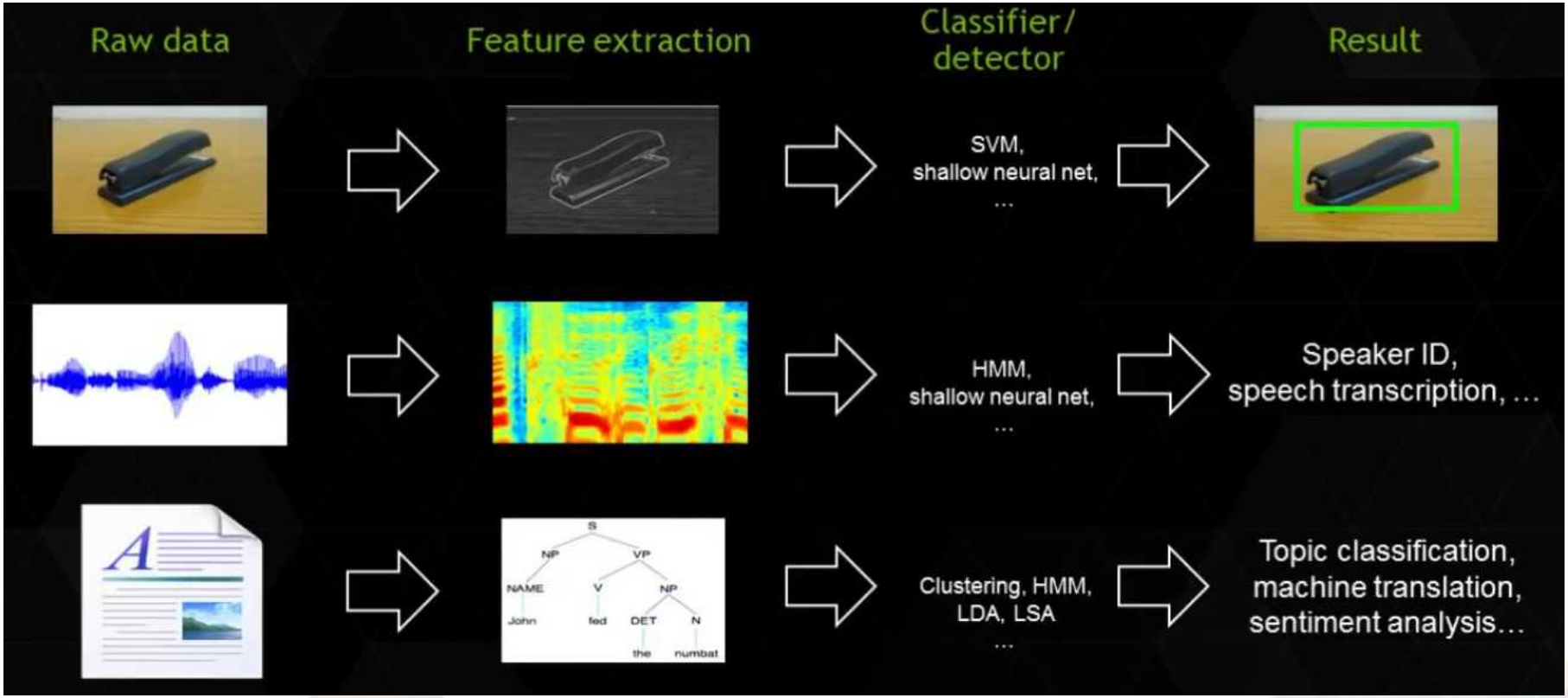
```
print(dataset.head(20))

print(dataset.describe())

print(dataset.groupby('class').size())
```

Deep Learning

- Deep learning is an area of machine learning that emerged from the intersection of neural networks, artificial intelligence, graphical modeling, optimization, pattern recognition and signal processing.

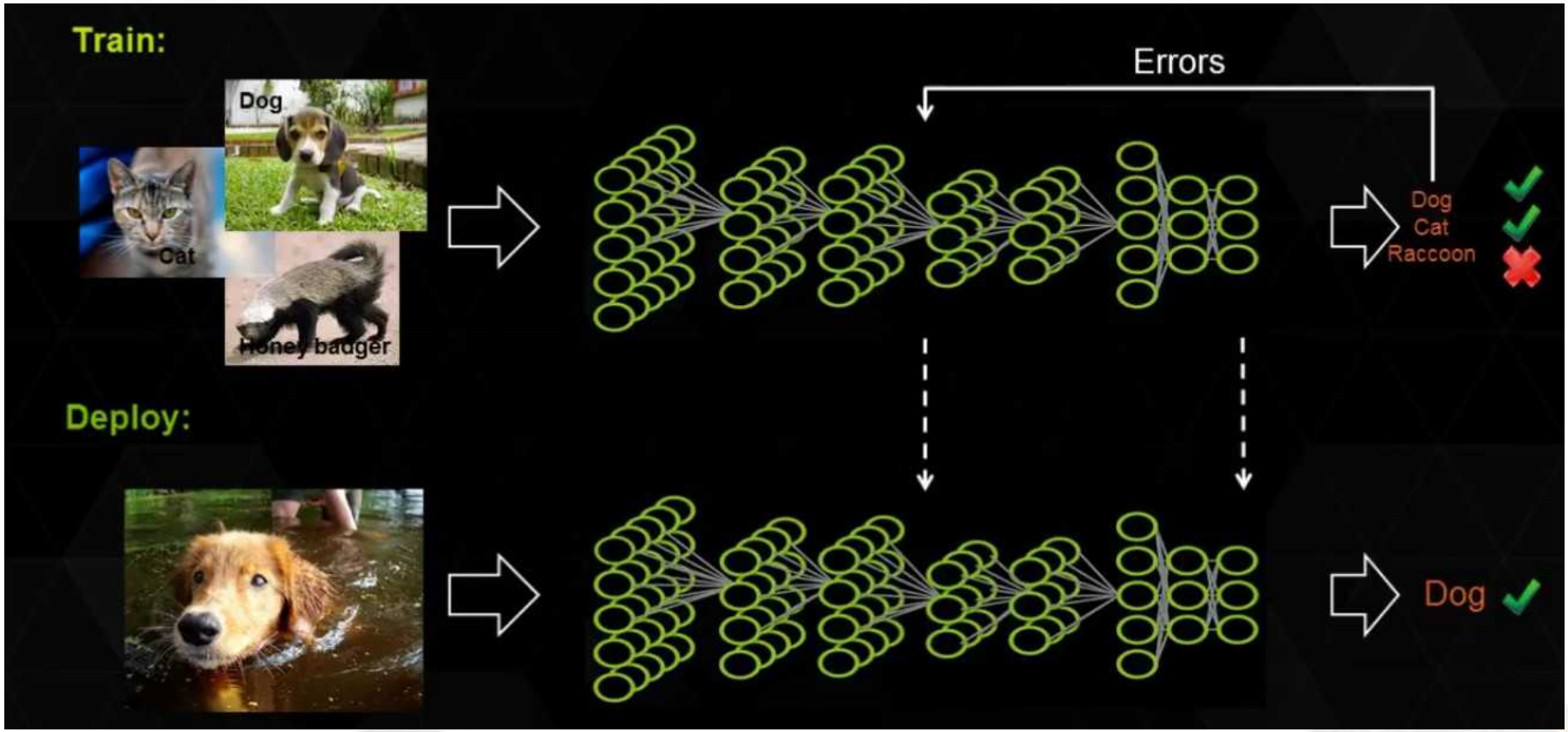
- Deep learning is about supervised or unsupervised learning from data using multiple layered machine learning models.
- The layers in these models consist of multiple stages of nonlinear data transformations, where features of the data are represented at successively higher, more abstract layers.

What is DL



- Deep learning methods aim at learning feature hierarchies with features from higher levels of the hierarchy formed by the composition of lower level features.
- The power of deep learning models comes from their ability to classify or predict nonlinear data using a modest number of parallel nonlinear steps.

DL Training


Train:
Dog
Cat
Honey badger
Errors
Dog
Cat
Raccoon
Deploy:
Dog

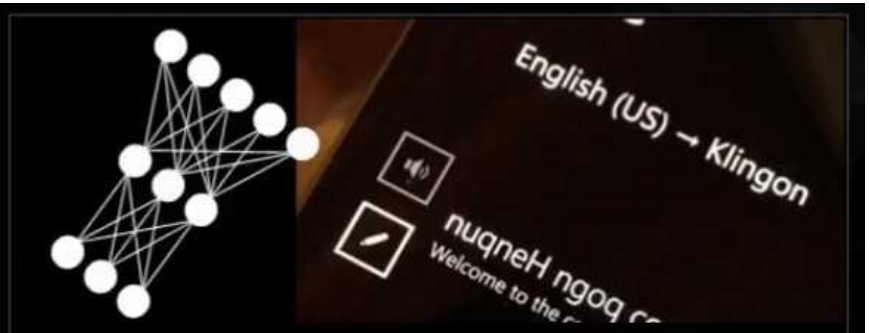
Importance of Deep Learning

- Robust
  - No need to design the features ahead of time - features are automatically learned to be optimal for the task at hand
  - Robustness to natural variations in the data is automatically learned
- Generalizable
  - The same neural net approach can be used for many different applications and data types
- Scalable
  - Performance improves with more data, method is massively parallelizable

Advantages of DL

Usage

Image Classification, Object Detection, Localization,
Action Recognition, Scene Understanding



Speech Recognition, Speech Translation,
Natural Language Processing

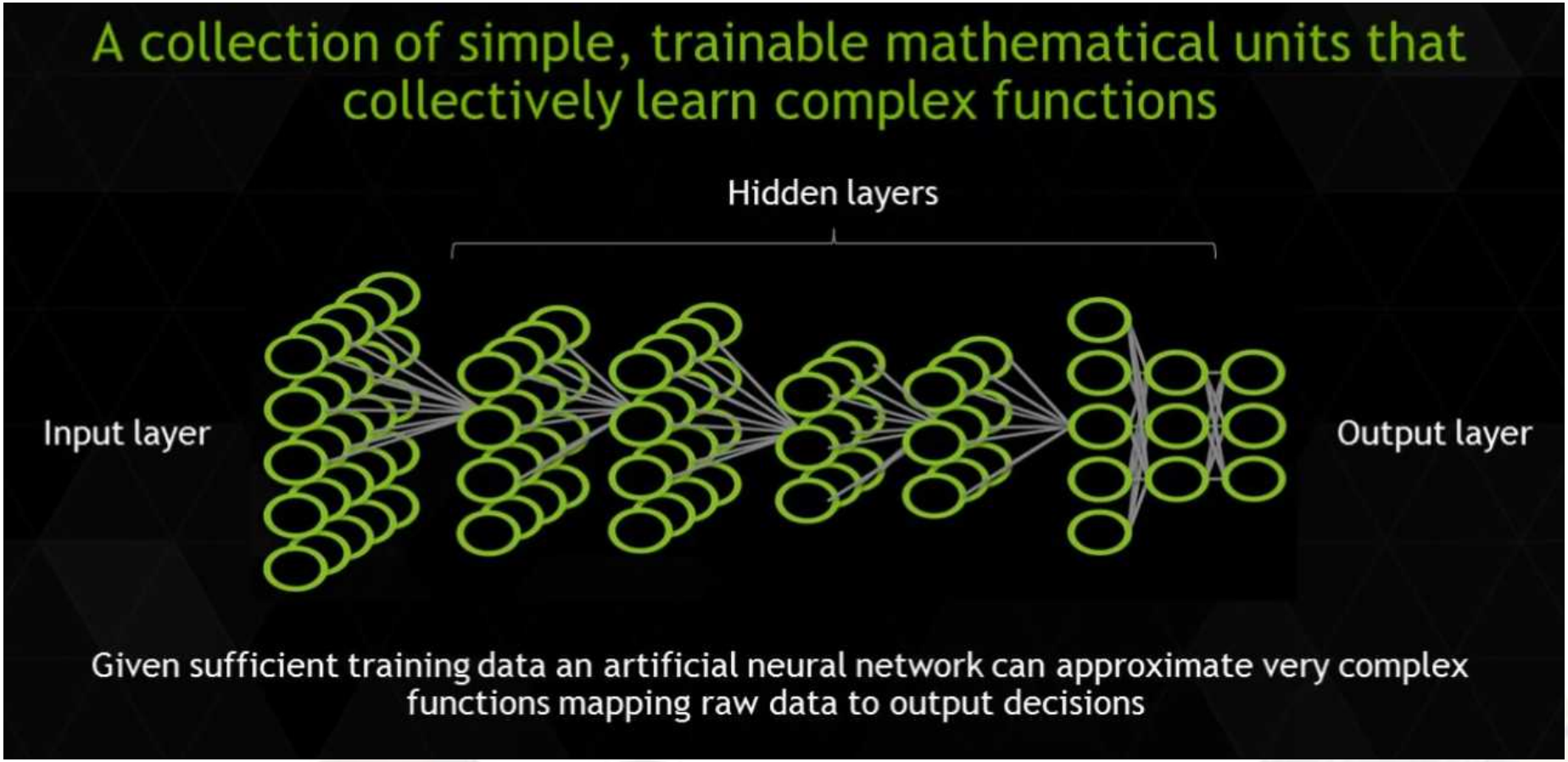
Pedestrian Detection, Traffic Sign Recognition

Breast Cancer Cell Mitosis Detection,
Volumetric Brain Image Segmentation

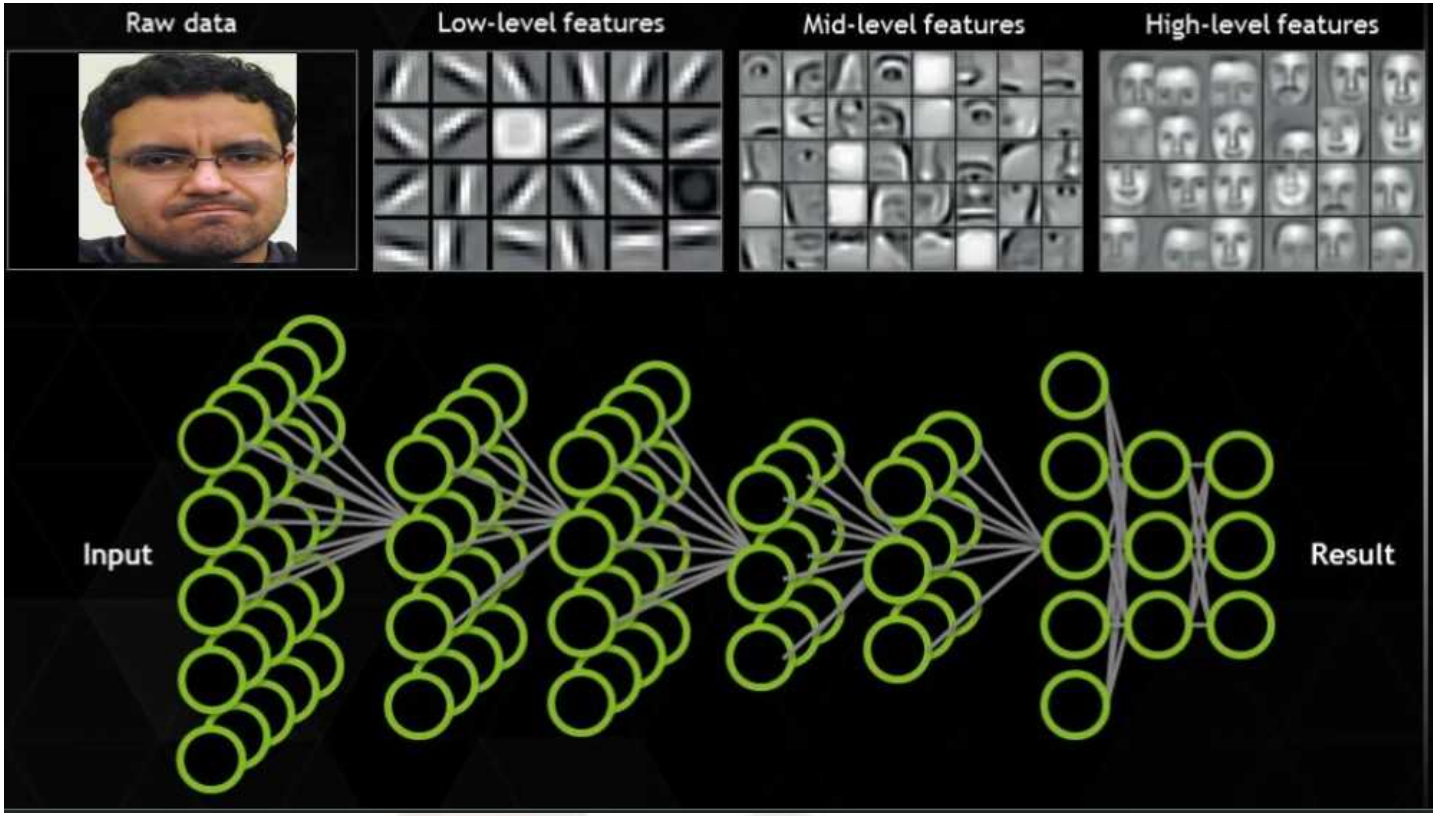
DL Architectures

- Deep learning architectures are basically artificial neural networks of multiple nonlinear layers and several types have been proposed according to input data characteristics and research objectives.
  - Deep Neural Network
  - Convolution Neural Network
  - Recurrent Neural Network
  - Emergent Architecture

Deep Neural Network



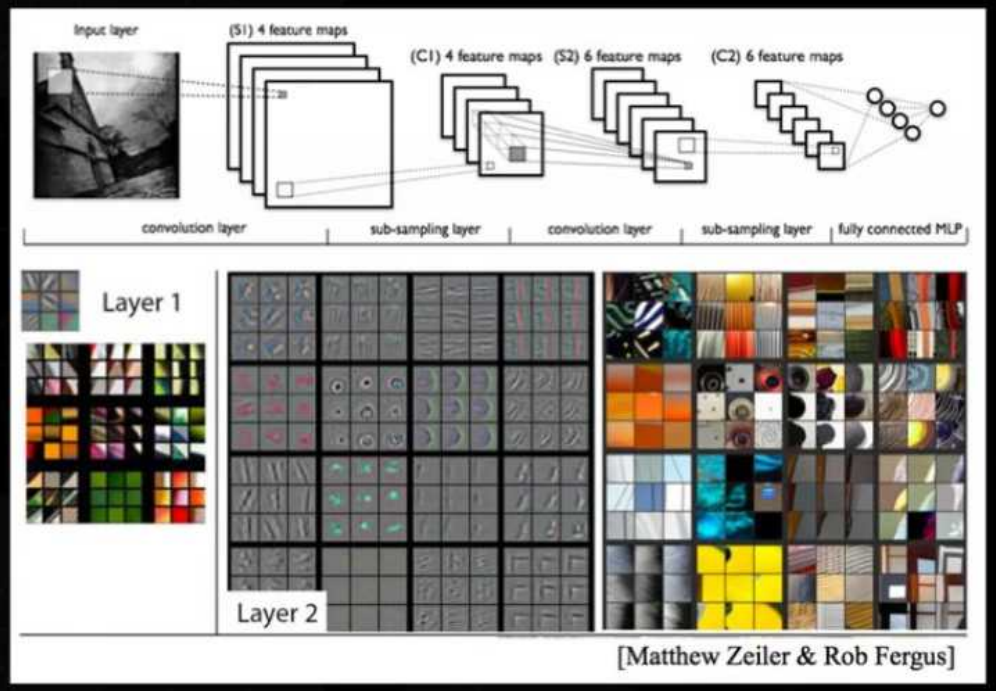
Deep Neural Network



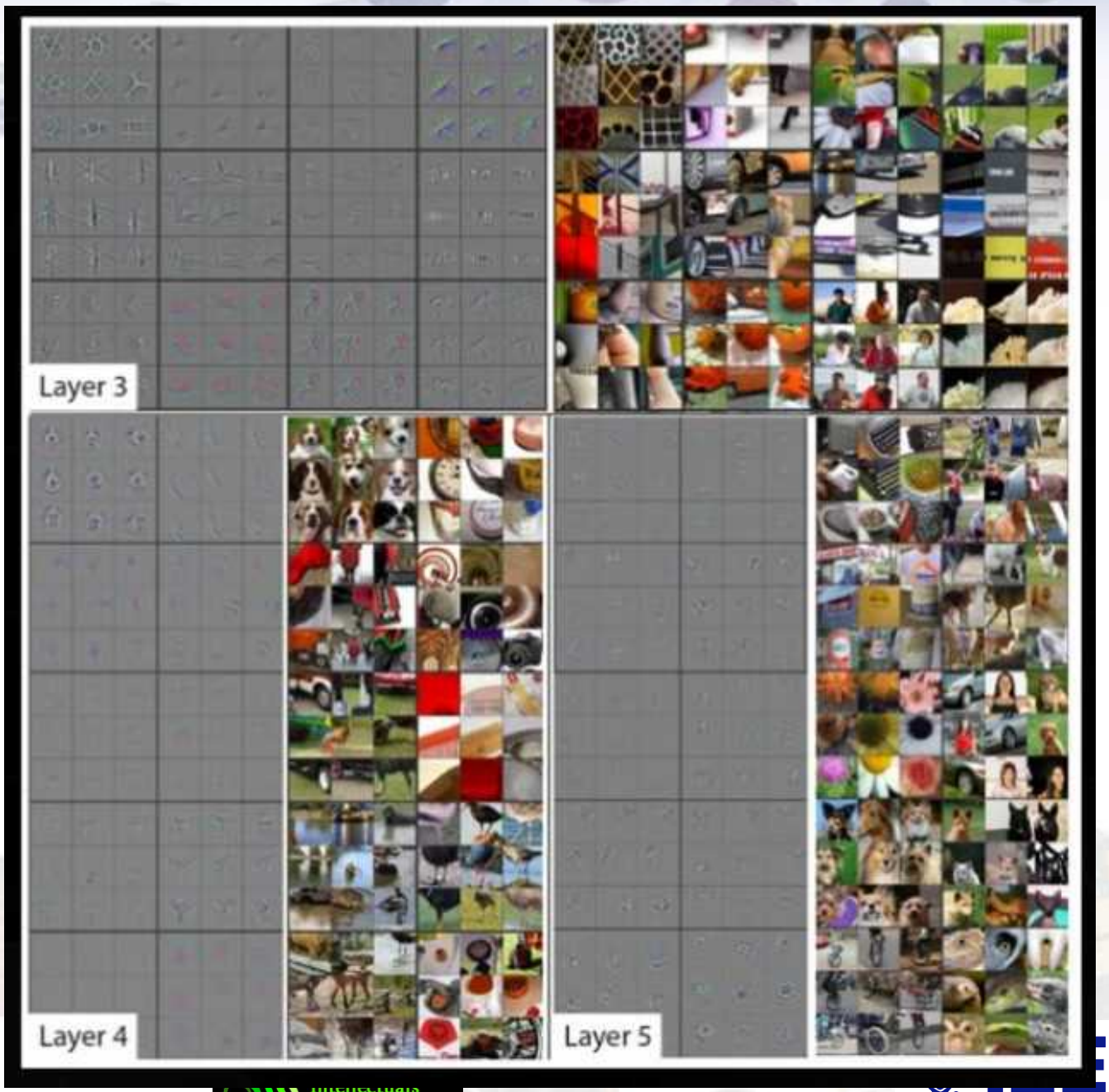
Application components:

Task objective
e.g. Identify face
Training data
10-100M images
Network architecture
~10 layers
1B parameters
Learning algorithm
~30 Exaflops
~30 GPU days

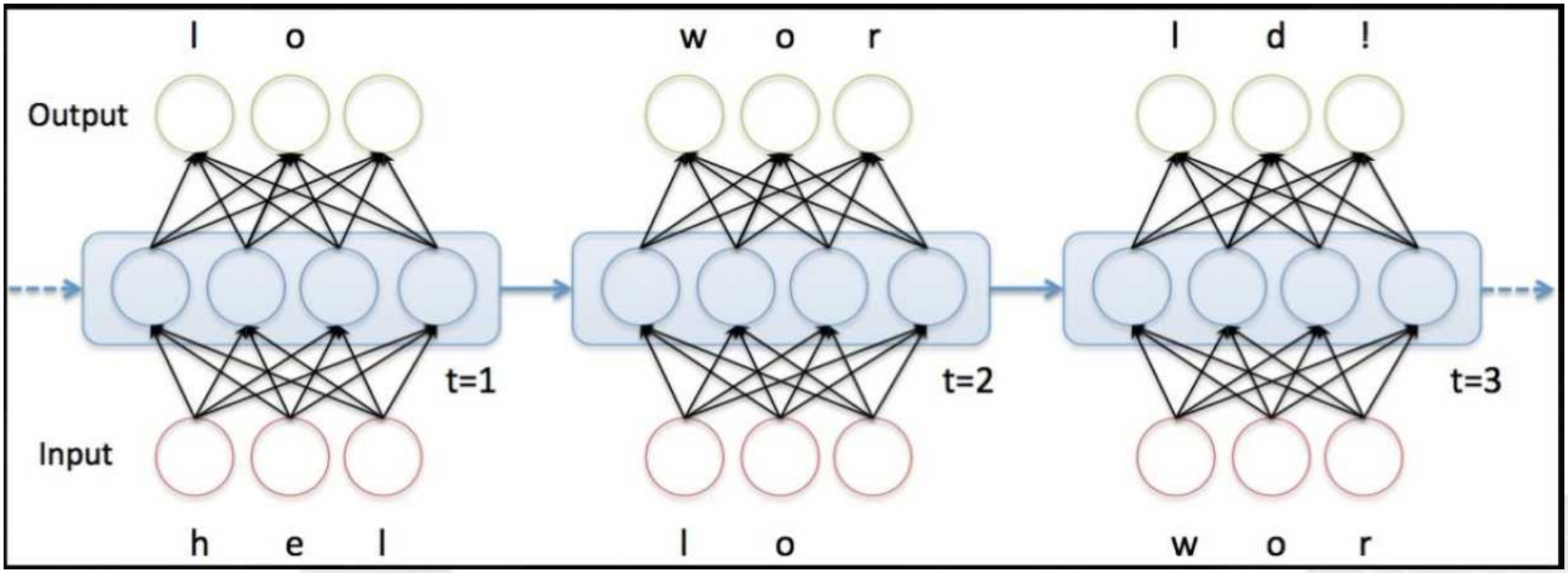
Convolution NN



- Inspired by the human visual cortex
- Learns a hierarchy of visual features
- Local pixel level features are scale and translation invariant
- Learns the “essence” of visual objects and generalizes well


Layer 3
Layer 4
Layer 5

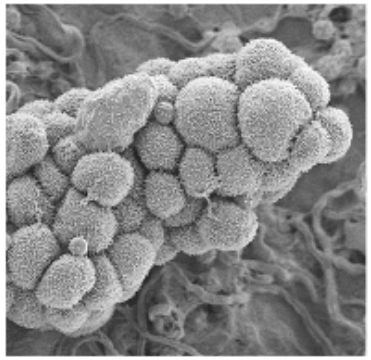
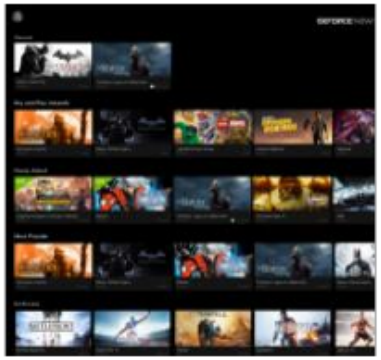
Recurrent NN

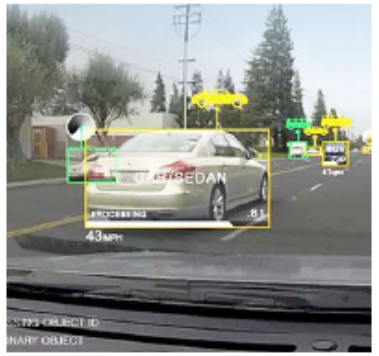


Machine Learning Vs Deep Learning

	Machine Learning	Deep Learning
Training dataset	Small	Large
Choose your own features	**Yes**	**No**
# of classifiers available	Many	Few
Training time	Short	Long

Deep Learning is 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

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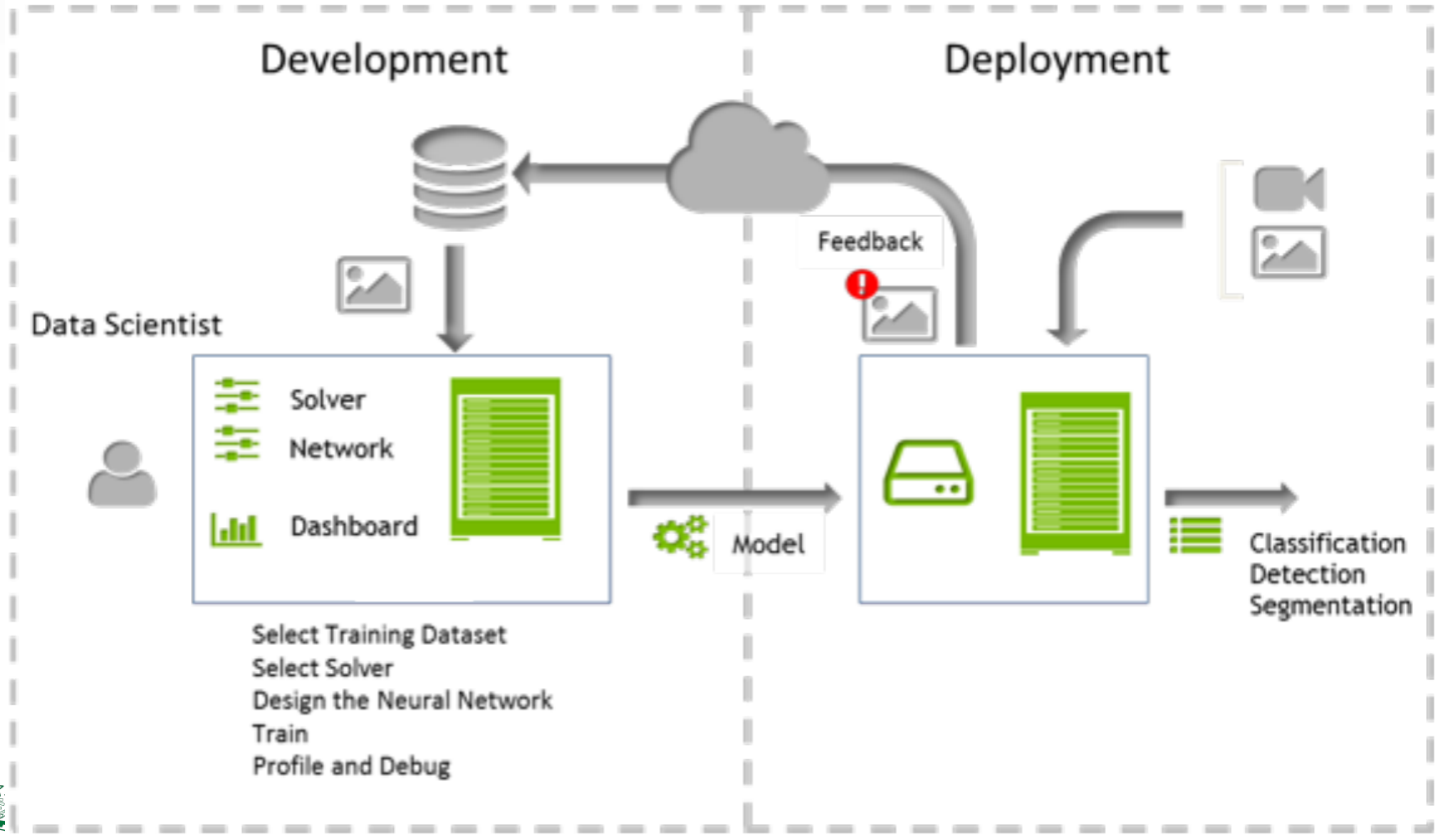
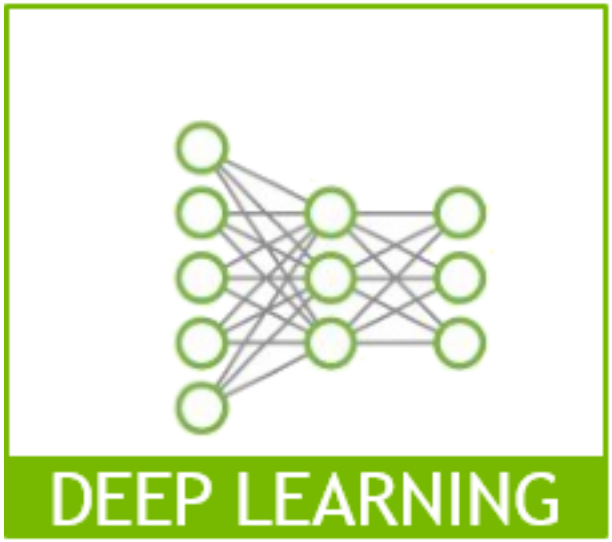
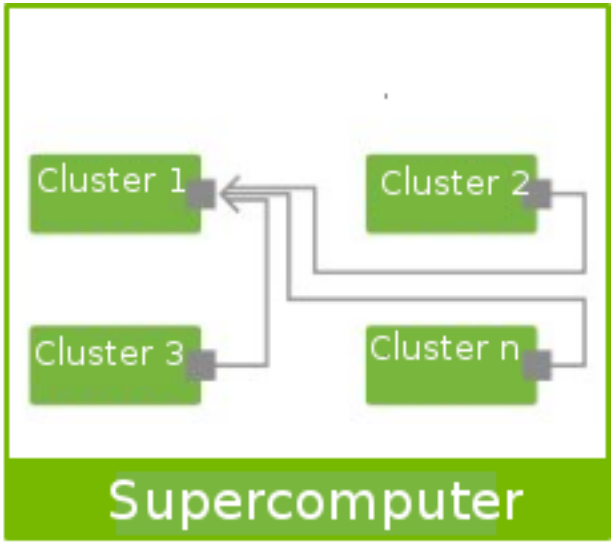
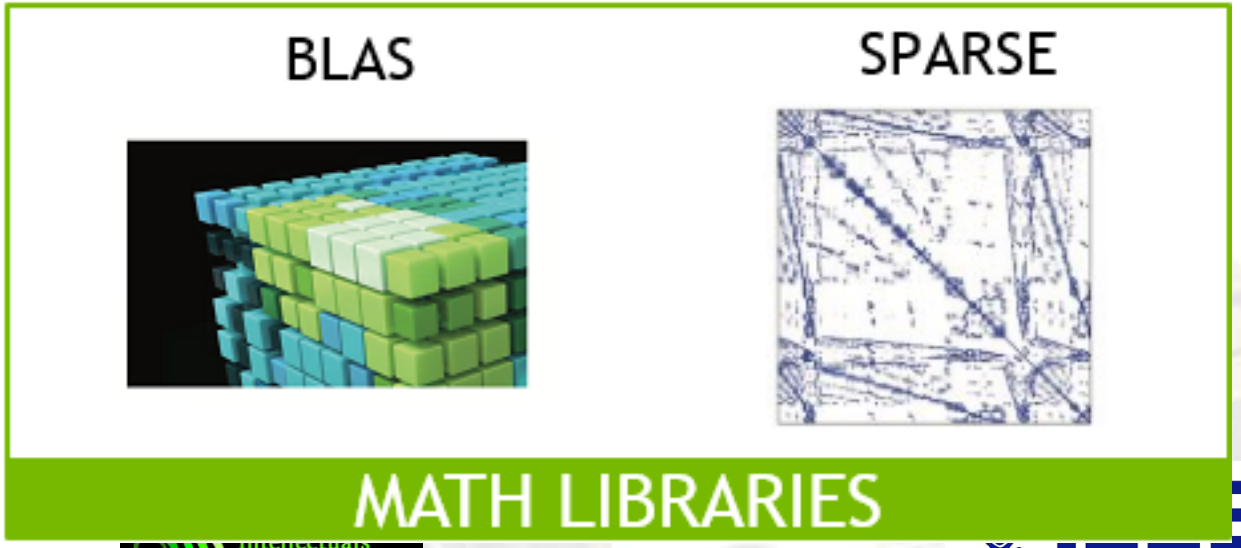

Development
Deployment
Feedback
Data Scientist
Solver
Network
Dashboard
Model
Classification
Detection
Segmentation
Select Training Dataset
Select Solver
Design the Neural Network
Train
Profile and Debug

Deep Learning Frameworks

Deep Learning System







Some Applications

- Process Modeling and Control.
- Health Diagnostics.
- Investment Portfolio Management.
- Military Target Recognition.
- Analysis of MRI and X-rays.
- Credit Rating of individuals by banks and other financial institutions.
- Marketing campaigns.
- Voice Recognition.

Proposals

- Deep learning for heart disease diagnosis
- A high performance system for real-time biomedical applications
- Artificial Intelligence for health-care
- EEG based real-time system
- Body area network system