REPUBLIC POLYTECHNIC
DISCOVER. TRANSFORM. ACHIEVE

Artificial Intelligence for Techies

A Hands-on Approach

Good Morning!

1) **Download the presentation slides and activities worksheet at http://bit.ly/aift_oct20**
2) **We will start at 9am sharp**

Sit back and relax for now ☺

Warm up!

Step 1: Go to the following url

https://bit.ly/kw_poll

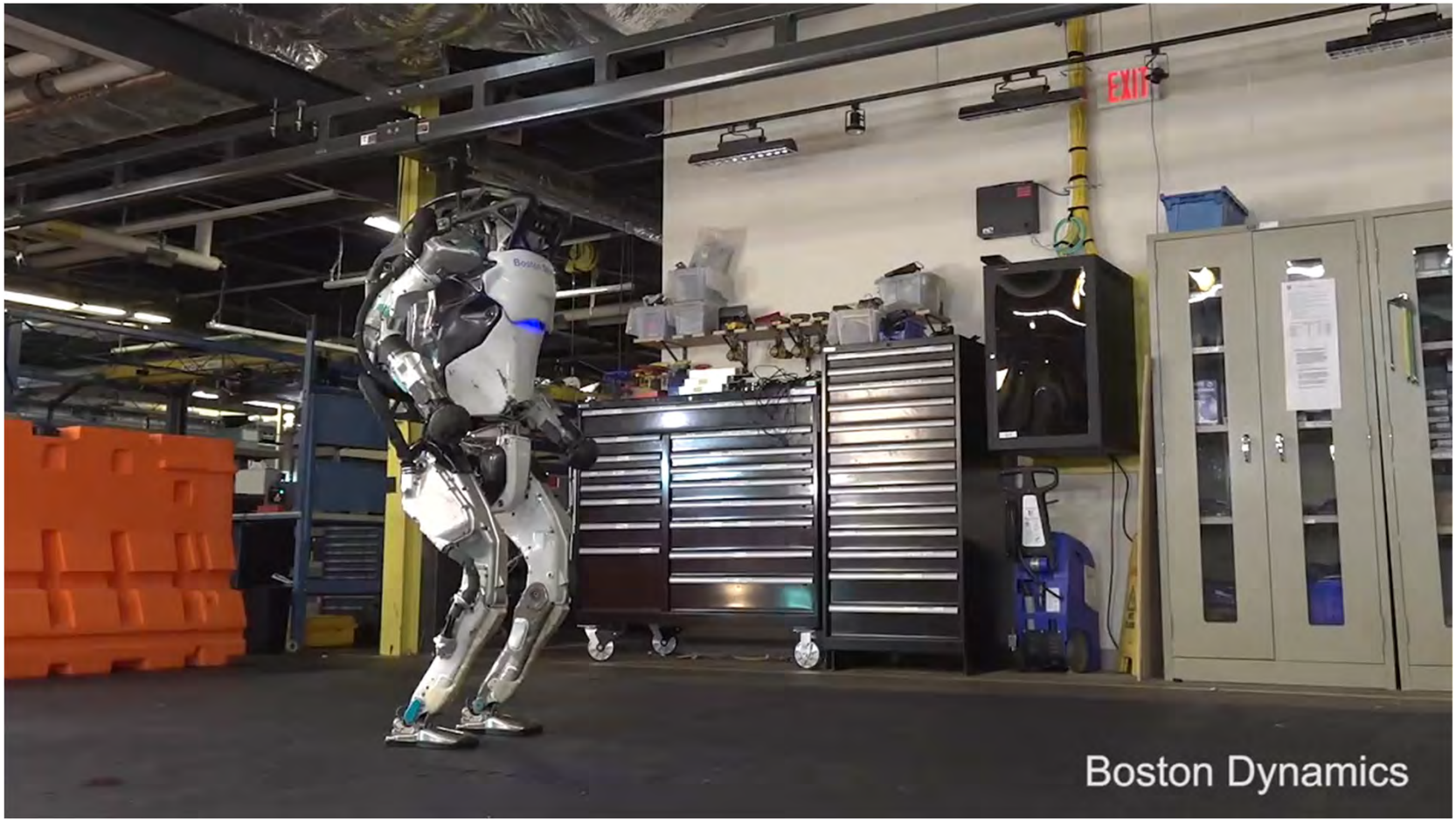
Step 2: facilitator will walk you through the following 2 questions

1) **Write down what you know about Artificial Intelligence**

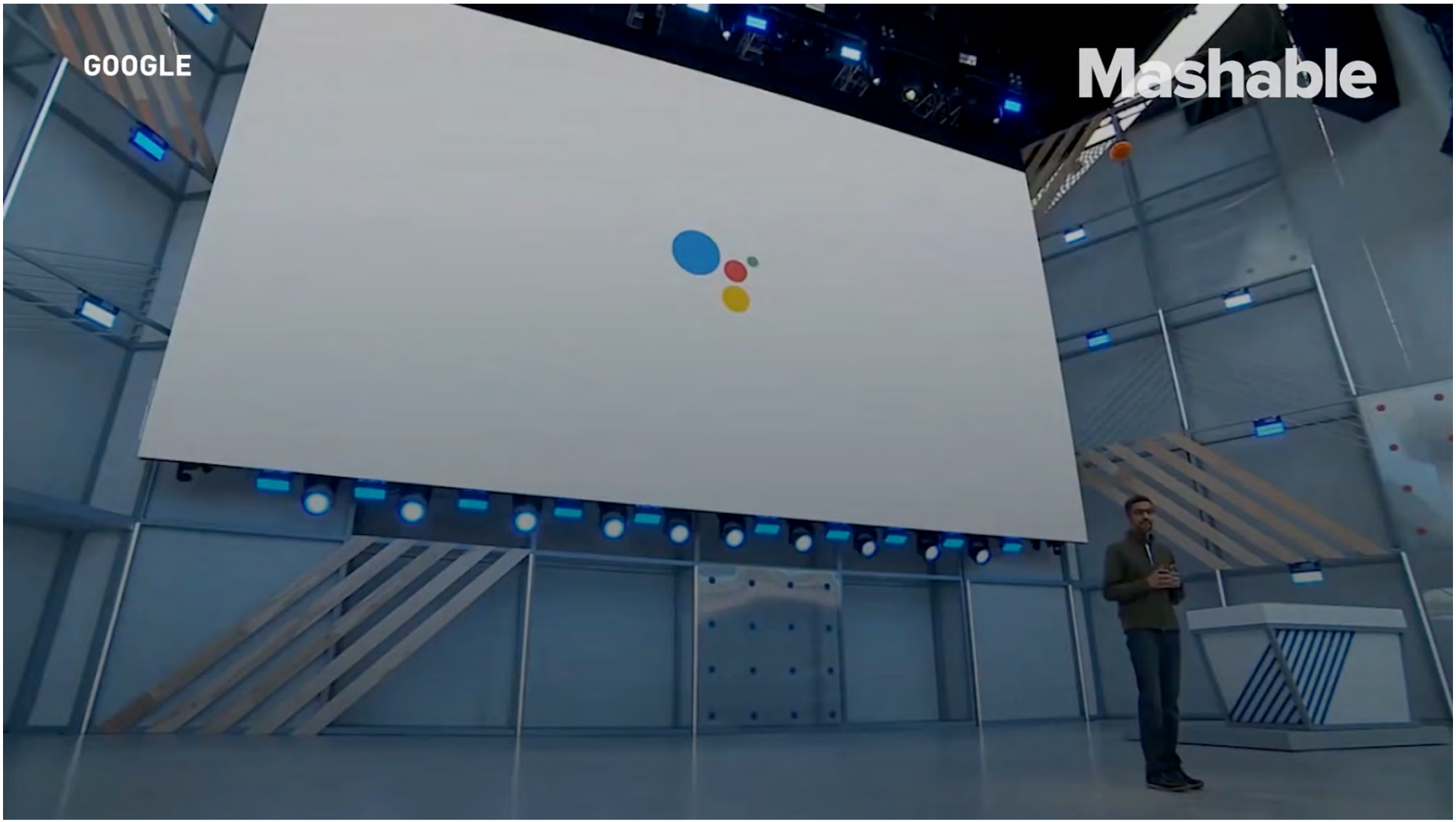
2) **What do you hope to gain from this workshop.**

5 mins

Robotics



AI assistant make real phone call



https://www.youtube.com/watch?v=JvbHu_bVa_g

Talk to flower

https://www.youtube.com/watch?v=nsPQvZm_rgM

Programme

Section 1:	Fundamental of Artificial Intelligence (45 mins)
Section 2:	Application of AI (30 mins)
Section 3:	Machine Learning and Deep Learning (45 mins)
Section 4:	AI technologies Demonstration and hands-on (15 mins)
	Lunch
Section 5:	AI Frameworks, software and hardware (30 mins)
Section 6:	AI Services (15 mins)
Section 7:	Practical Text Analytics using AI services(1 hour)
Section 8:	Practical Computer Vision using a programming framework (1 hour)

Introduction of trainer

Name
Seow Khee Wei

Telegram
@kwseow

Email
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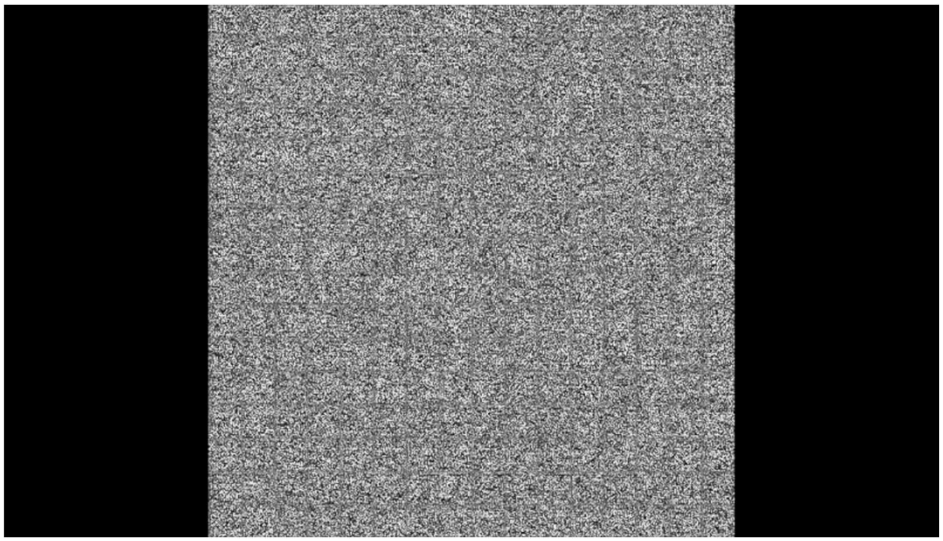
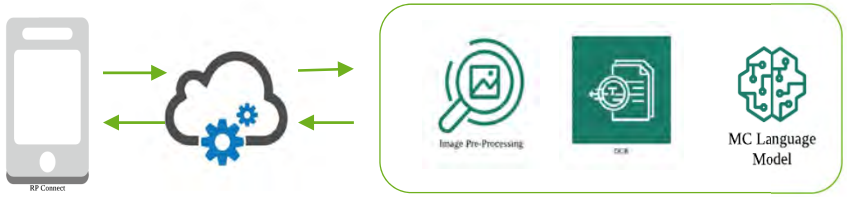
Projects


Total count
Age
Age Groups
Male vs Female
Emotion
Emo Groups
Tracking|48|74|3517|8731|2019/01/21 21:42:18
CAPTURED FACES
VISITORS
TOTAL 122
MALE 18
FEMALE 33
AGE
YOUTH 36
YOUNG ADULT 13
ADULT 0
SENIOR 2
EMOTIONS
ANGRY 6
SCARED 8
HAPPY 4
SAD 14
SURPRISED 3
NEUTRAL 16




Silver Cross Medical
SILVER CROSS CLINIC
MEDICAL CERTIFICATE
UNFIT FOR SCHOOL
REMARKS:
Dr Low Sau Wai
DR. LOW SAU WAI (M61492J)

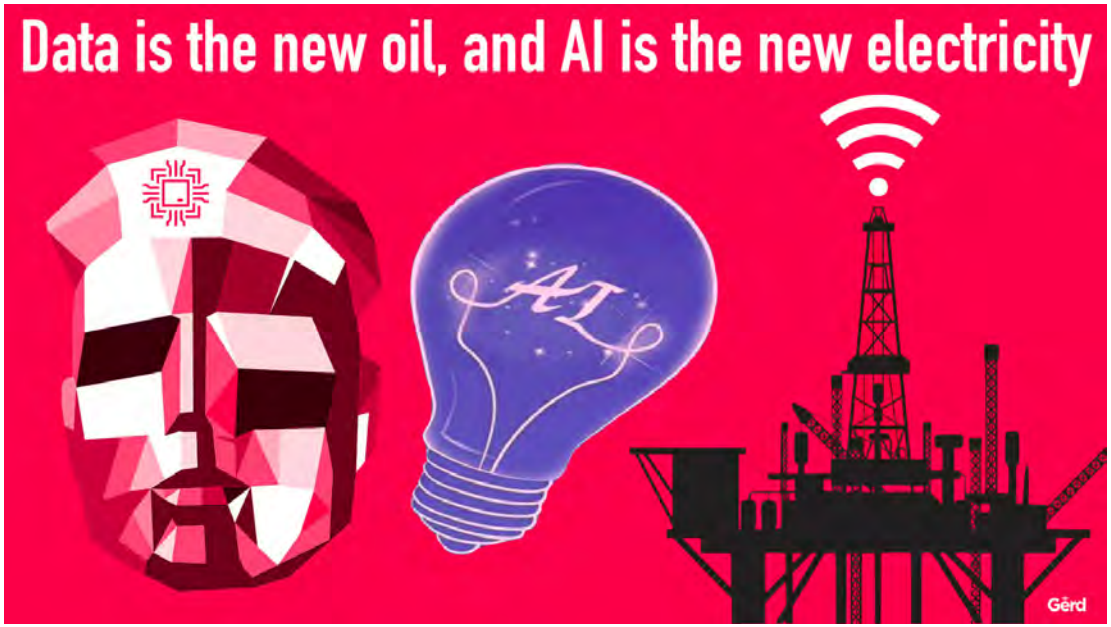

RP Connect
Image Pre-Processing
MC Language Model

What is Artificial Intelligence?

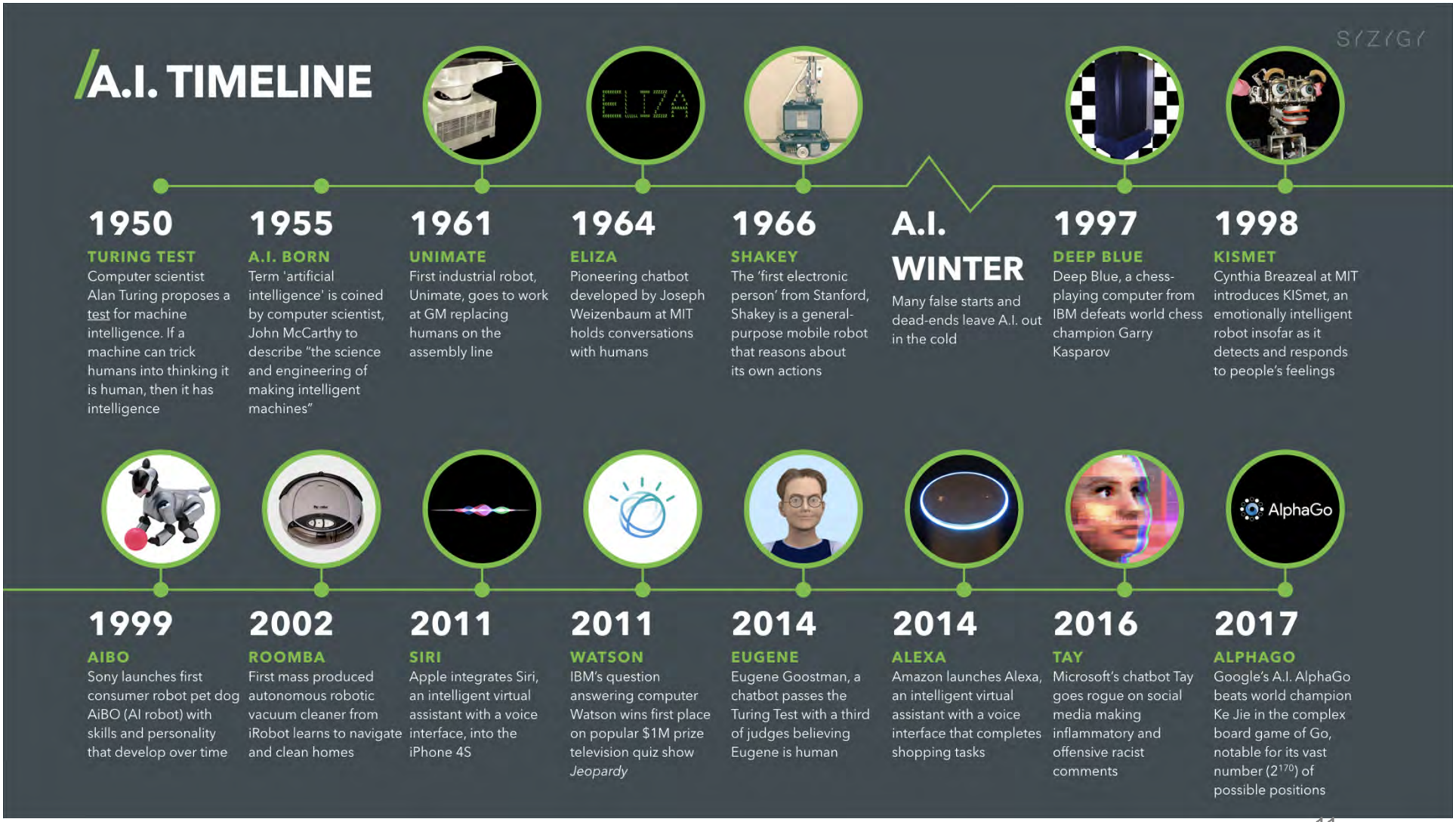
- The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision making, and translation between languages." – Google

AI is the new electricity

“About 100 years ago, electricity transformed every major industry. AI has advanced to the point where it has the power to transform” every major sector in coming years.– Andrew Ng



History of AI

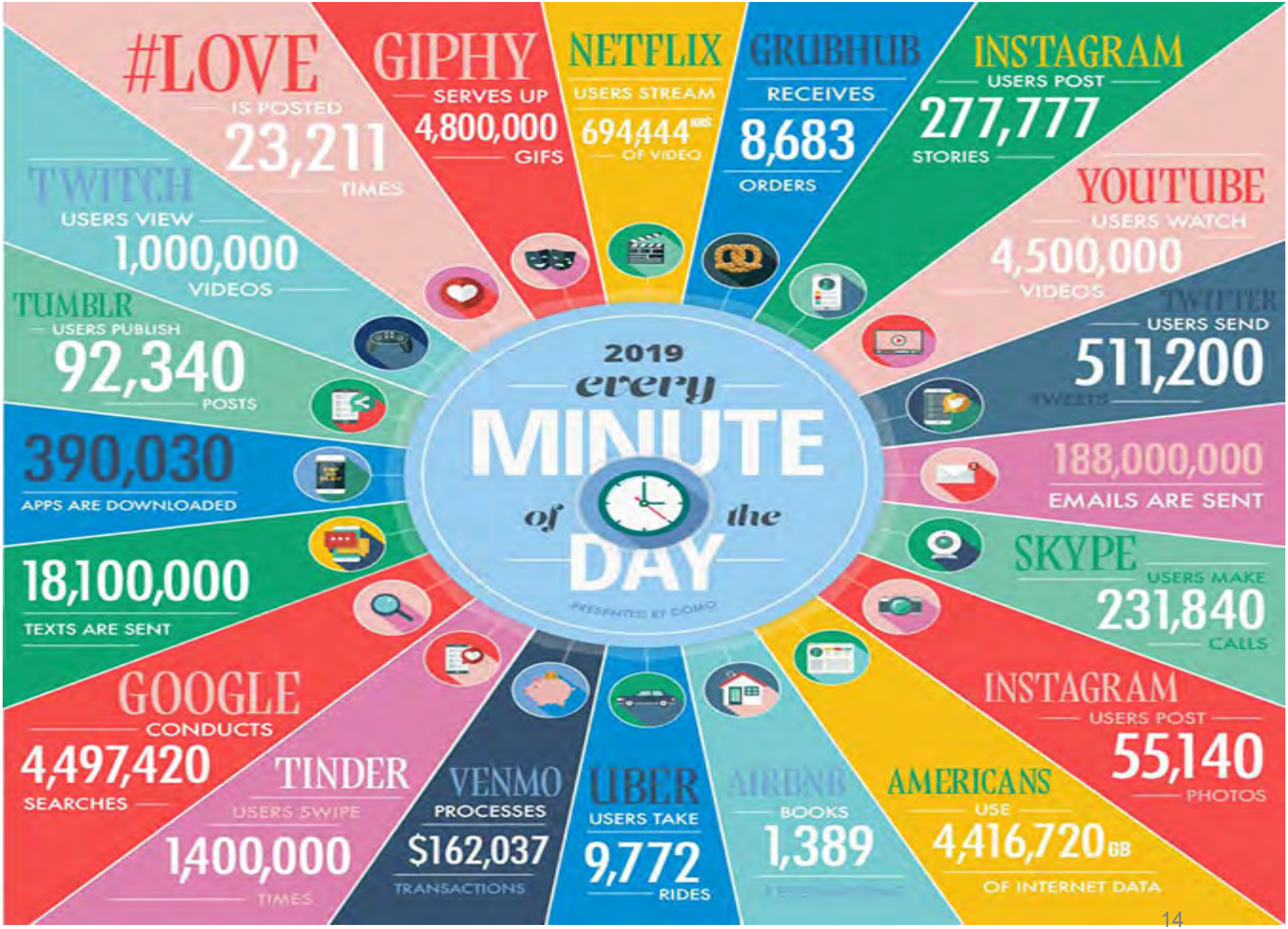


Why???

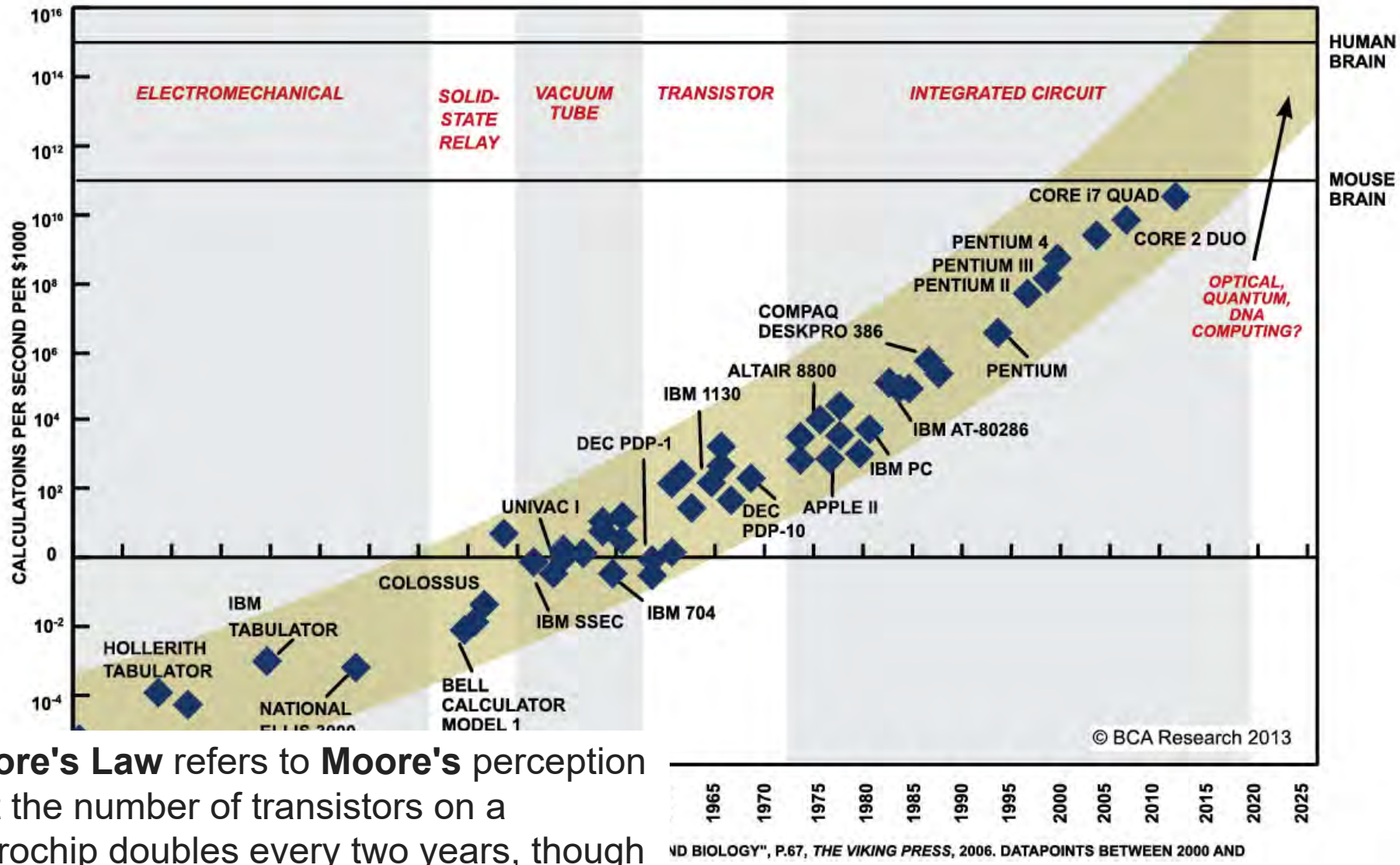
Bigger Datasets

In 2020, it is expected that:

- The average internet user will generate ~1.5 GB of traffic per day.
- A smart hospital will generate 3,000 GB/day.
- Self-driving cars are each generating over 4,000 GB/day.
- Connected planes will generate 40,000 gigabytes per day.
- A connected factory will generate 1 million gigabytes per day.

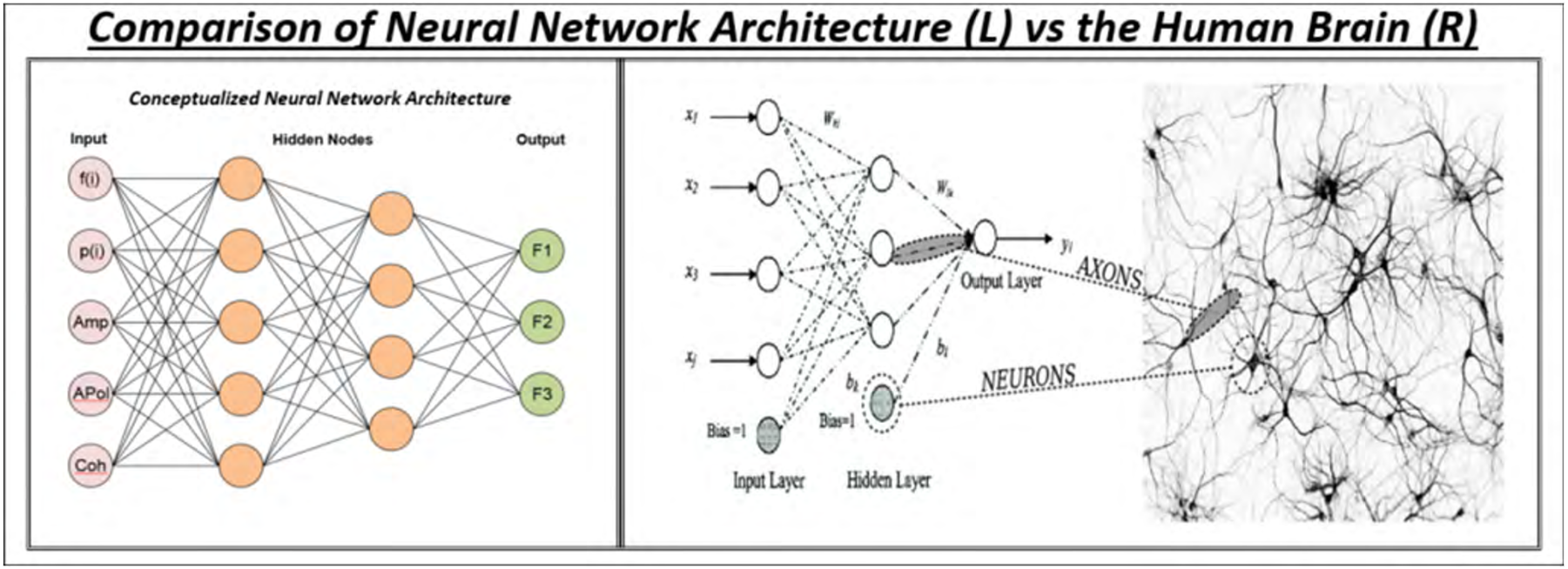

#LOVE
IS POSTED
23,211
TIMES
GIPHY
SERVES UP
4,800,000
GIFS
NETFLIX
USERS STREAM
694,444
OF VIDEO
GRUBHUB
RECEIVES
8,683
ORDERS
INSTAGRAM
USERS POST
277,777
STORIES
TWITCH
USERS VIEW
1,000,000
VIDEOS
YOUTUBE
USERS WATCH
4,500,000
VIDEOS
TUMBLR
USERS PUBLISH
92,340
POSTS
TWITTER
USERS SEND
511,200
TWEETS
2019
every
MINUTE
of the
DAY
PRESENTED BY DOMO
390,030
APPS ARE DOWNLOADED
188,000,000
EMAILS ARE SENT
18,100,000
TEXTS ARE SENT
SKYPE
USERS MAKE
231,840
CALLS
GOOGLE
CONDUCTS
4,497,420
SEARCHES
INSTAGRAM
USERS POST
55,140
PHOTOS
TINDER
USERS SWIPE
1,400,000
TIMES
VENMO
PROCESSES
$162,037
TRANSACTIONS
UBER
USERS TAKE
9,772
RIDES
AIRBNB
BOOKS
1,389
AMERICANS
USE
4,416,720 GB
OF INTERNET DATA

Moore's Law



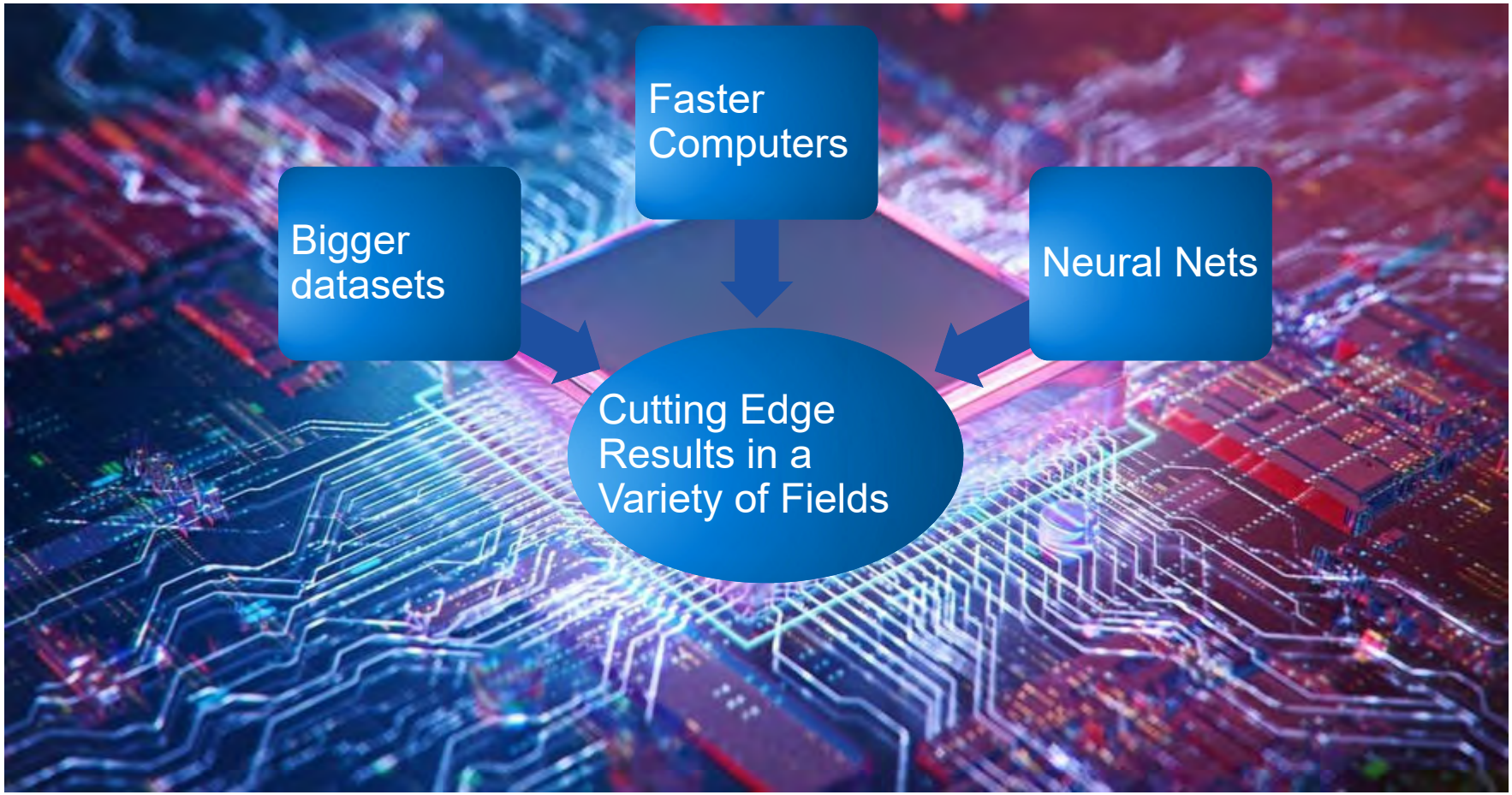
Moore's Law refers to **Moore's** perception that the number of transistors on a microchip doubles every two years, though the cost of computers is halved.

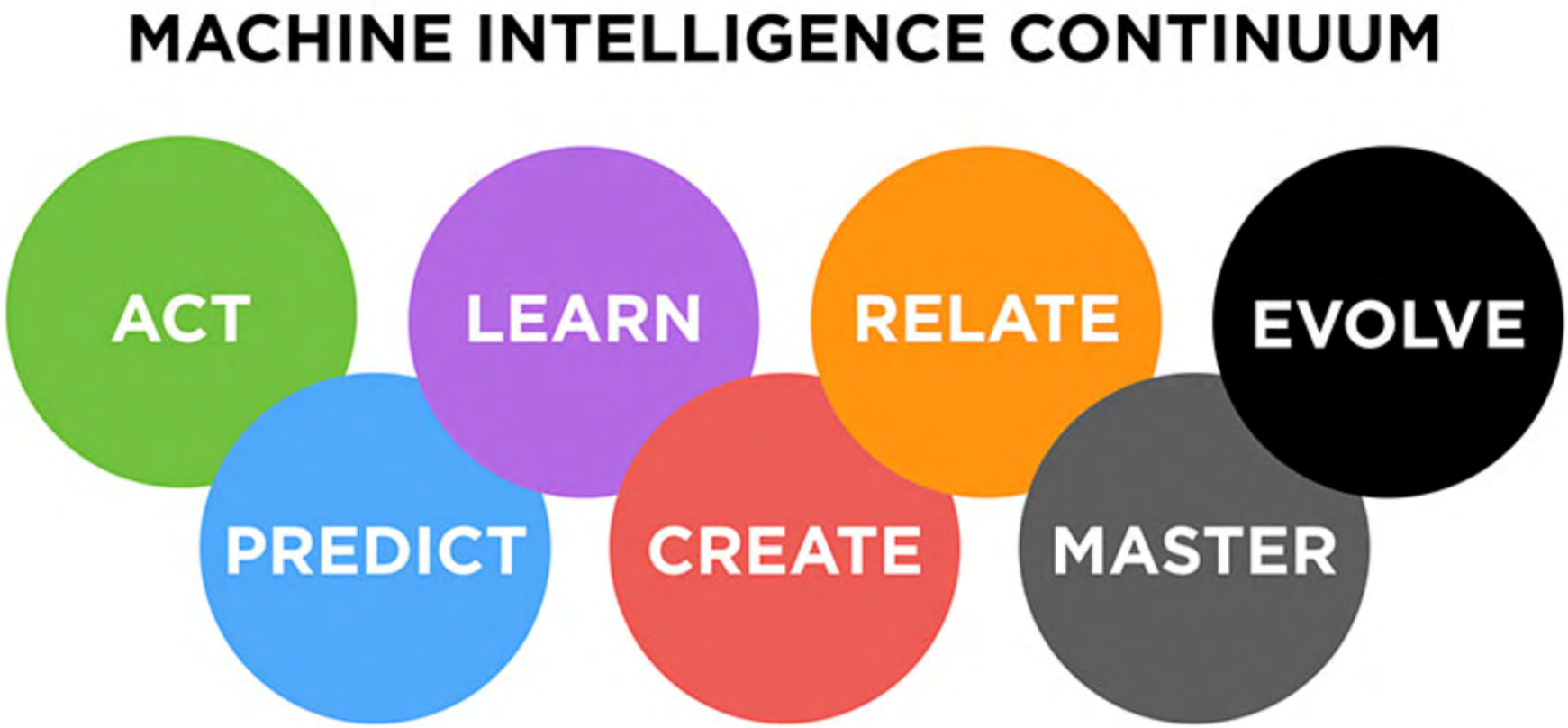
Neural Network



AI Hardware

Faster hardware is one of the key areas driving the modern era of AI.





The MIC represents a continuum from simple, scripted automation to superhuman intelligence and highlights the functional capabilities of different levels of machine intelligence.

https://www.topbots.com/topbots-ai-machine-intelligence-continuum/?utm_medium=article&utm_source=medium&utm_campaign=AI-Continuum

Systems that Acts

https://www.topbots.com/topbots-ai-machine-intelligence-continuum/?utm_medium=article&utm_source=medium&utm_campaign=AI-Continuum

Systems that Predicts

https://www.topbots.com/topbots-ai-machine-intelligence-continuum/?utm_medium=article&utm_source=medium&utm_campaign=AI-Continuum

Systems that Learns

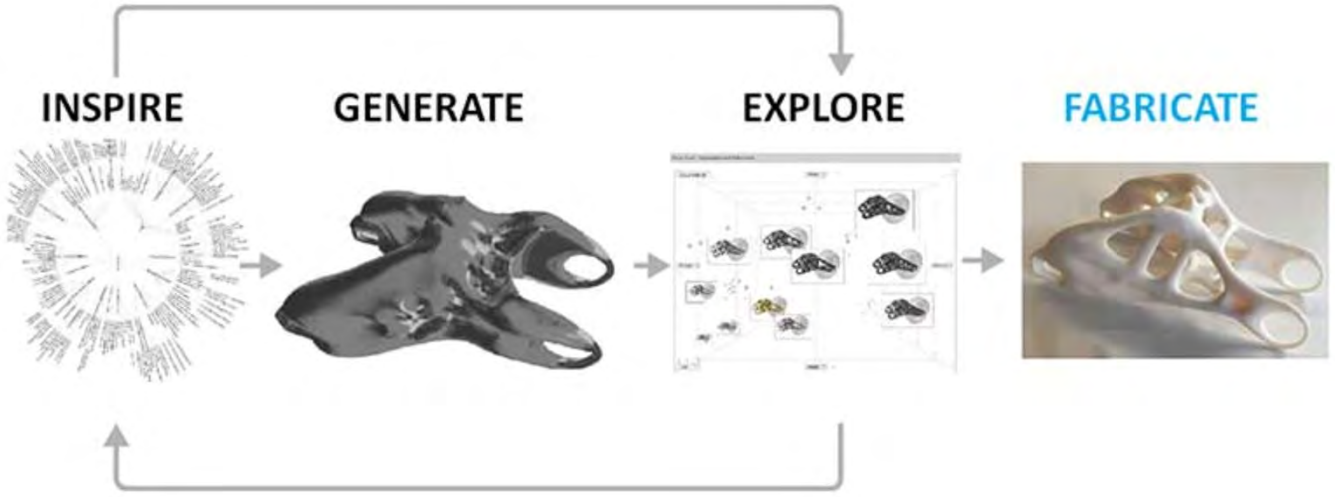
https://www.topbots.com/topbots-ai-machine-intelligence-continuum/?utm_medium=article&utm_source=medium&utm_campaign=AI-Continuum

Systems that Create

Generated story about image
Model: Romantic Novels

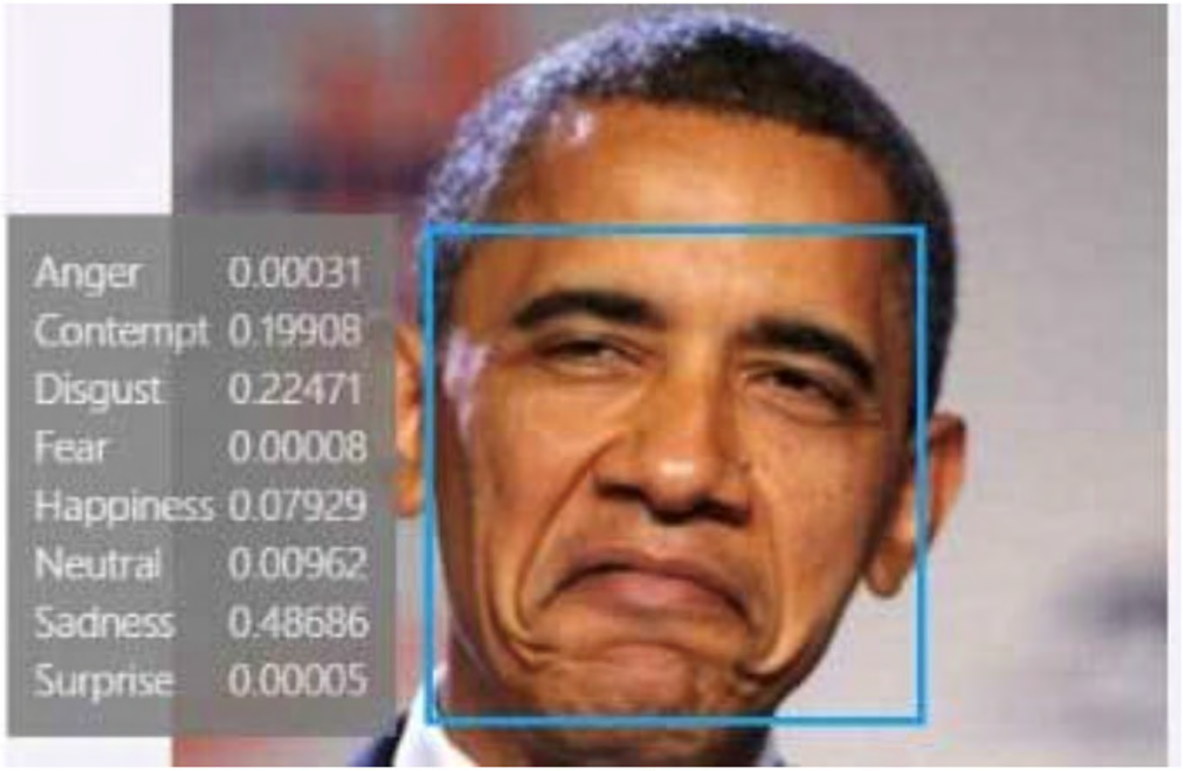
"He was a shirtless man in the back of his mind, and I let out a curse as he leaned over to kiss me on the shoulder.

He wanted to strangle me, considering the beatiful boy I'd become wearing his boxers."



https://www.topbots.com/topbots-ai-machine-intelligence-continuum/?utm_medium=article&utm_source=medium&utm_campaign=AI-Continuum

Systems that Relate

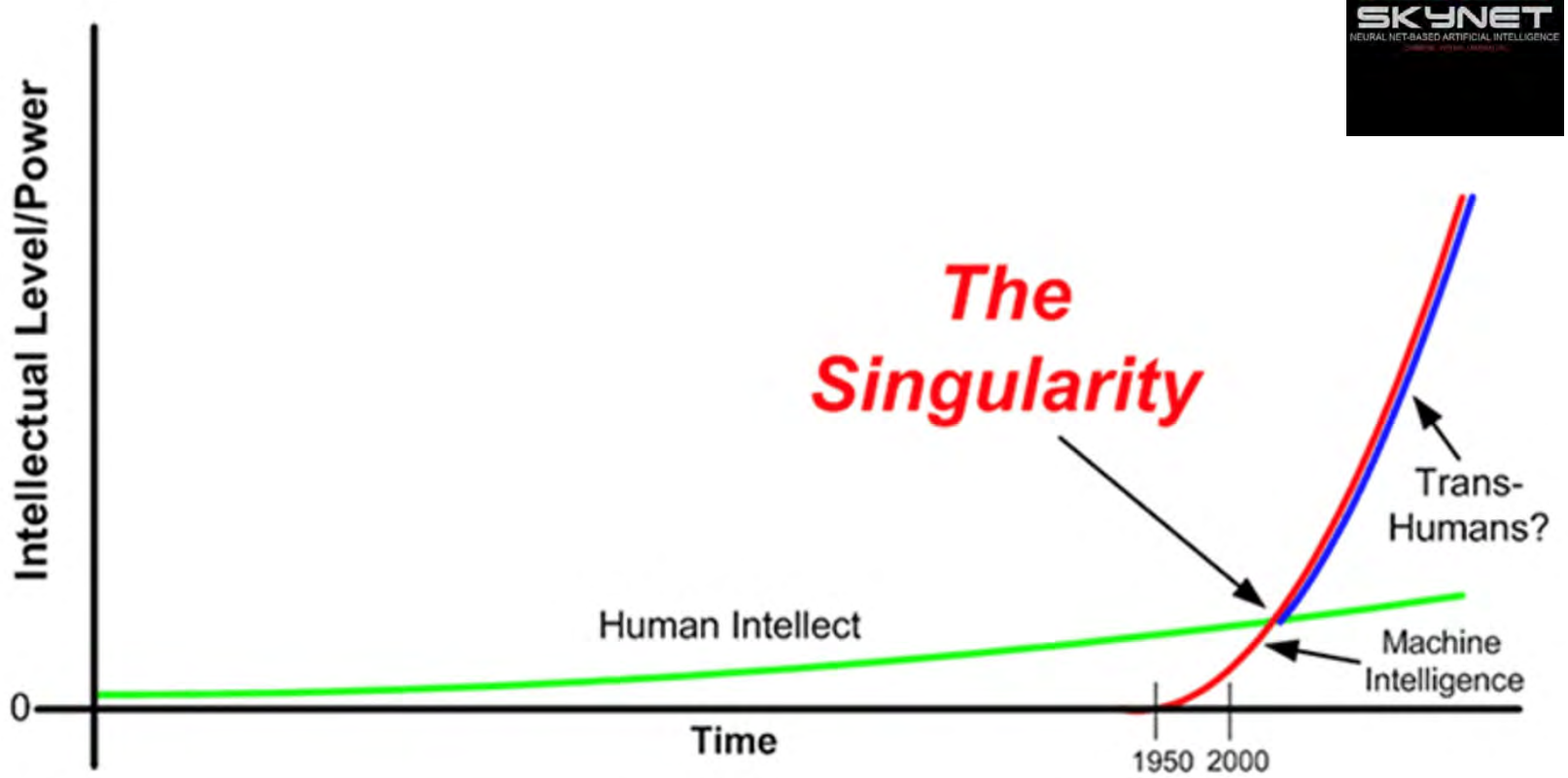


https://www.topbots.com/topbots-ai-machine-intelligence-continuum/?utm_medium=article&utm_source=medium&utm_campaign=AI-Continuum

Systems that Master

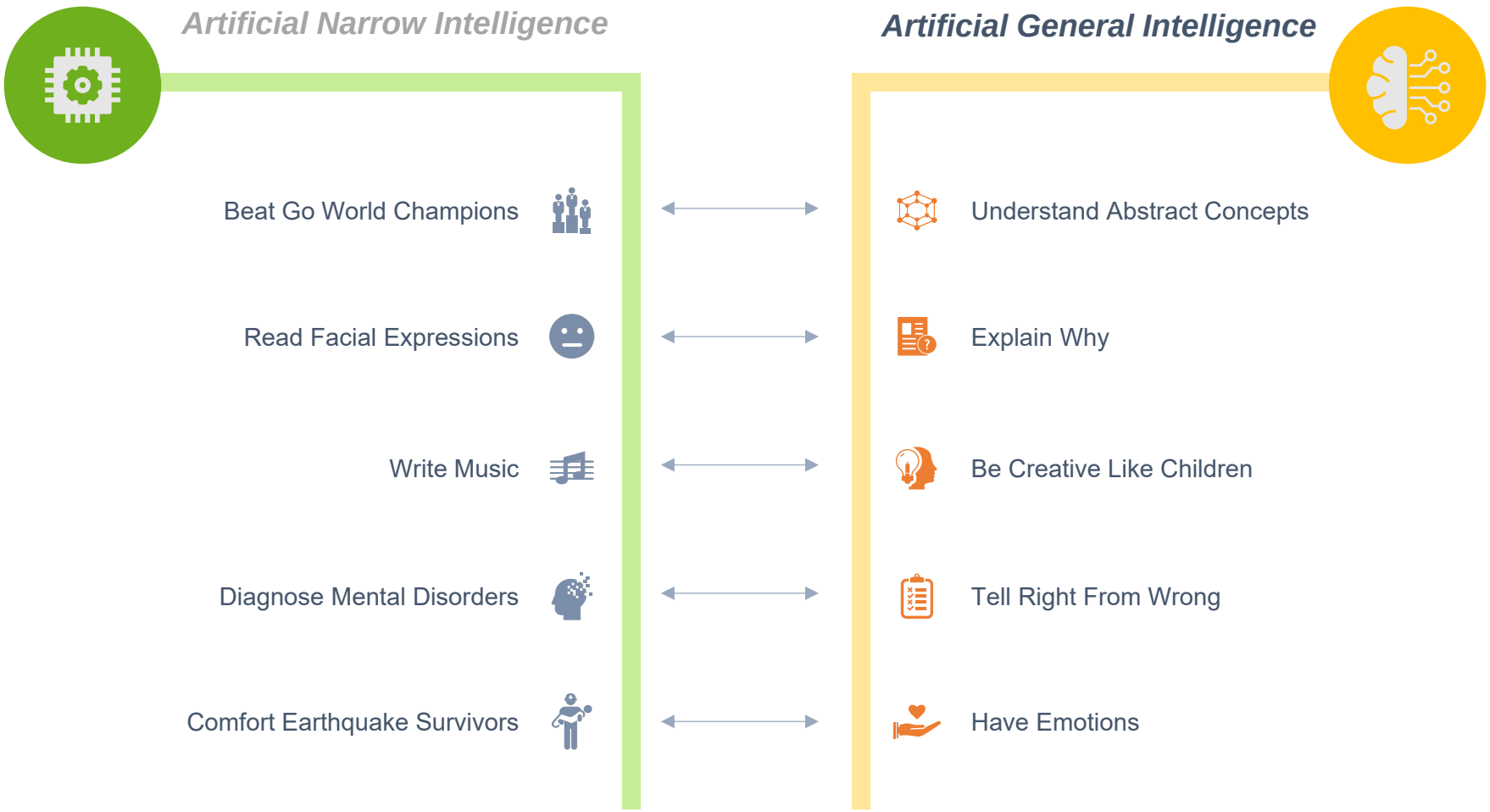
https://www.topbots.com/topbots-ai-machine-intelligence-continuum/?utm_medium=article&utm_source=medium&utm_campaign=AI-Continuum

Systems that Evolve

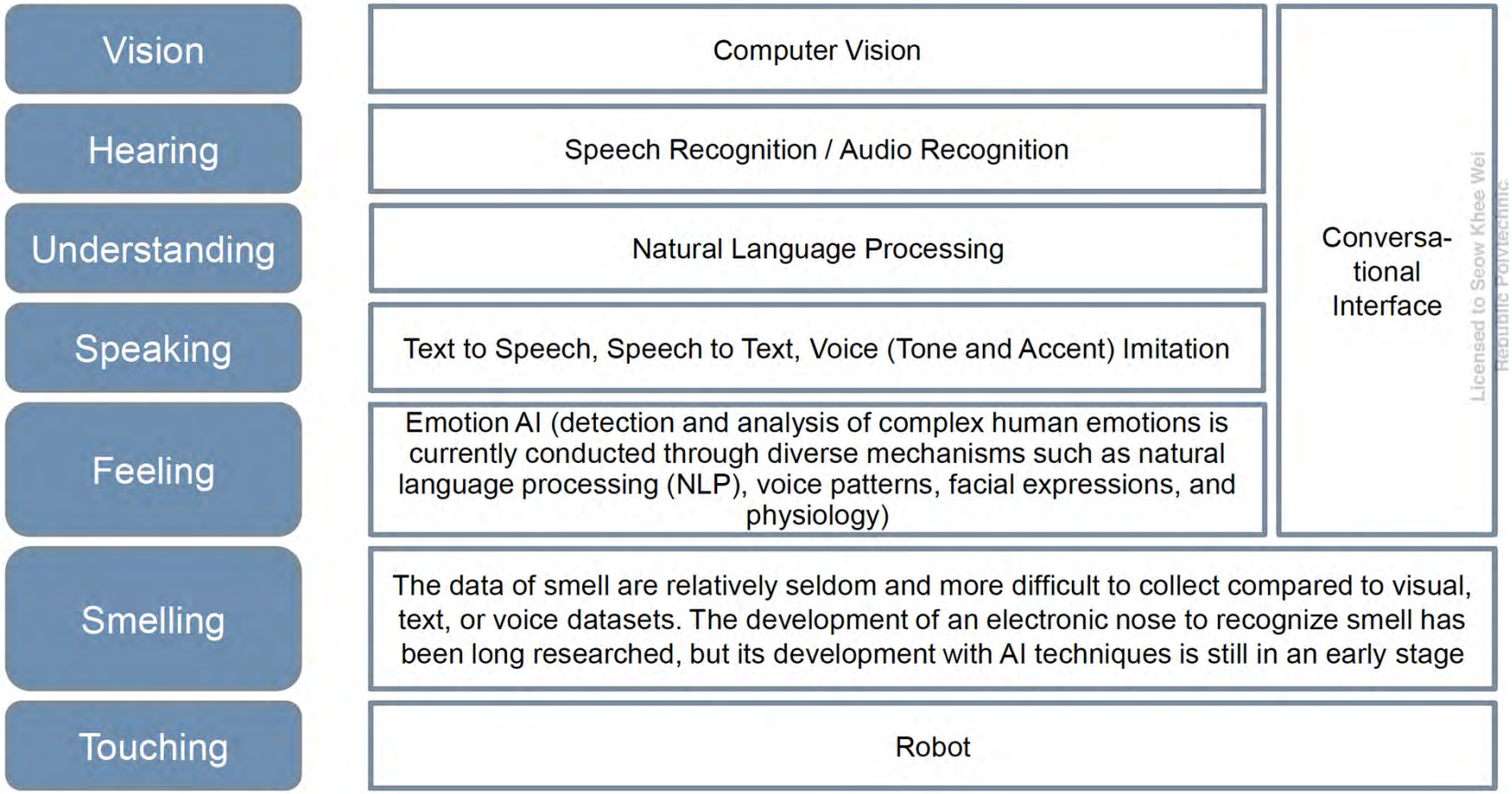


https://www.topbots.com/topbots-ai-machine-intelligence-continuum/?utm_medium=article&utm_source=medium&utm_campaign=AI-Continuum

Artificial Narrow Intelligence vs Artificial General



Mapping Human Perceptions to AI-enabled Capabilities

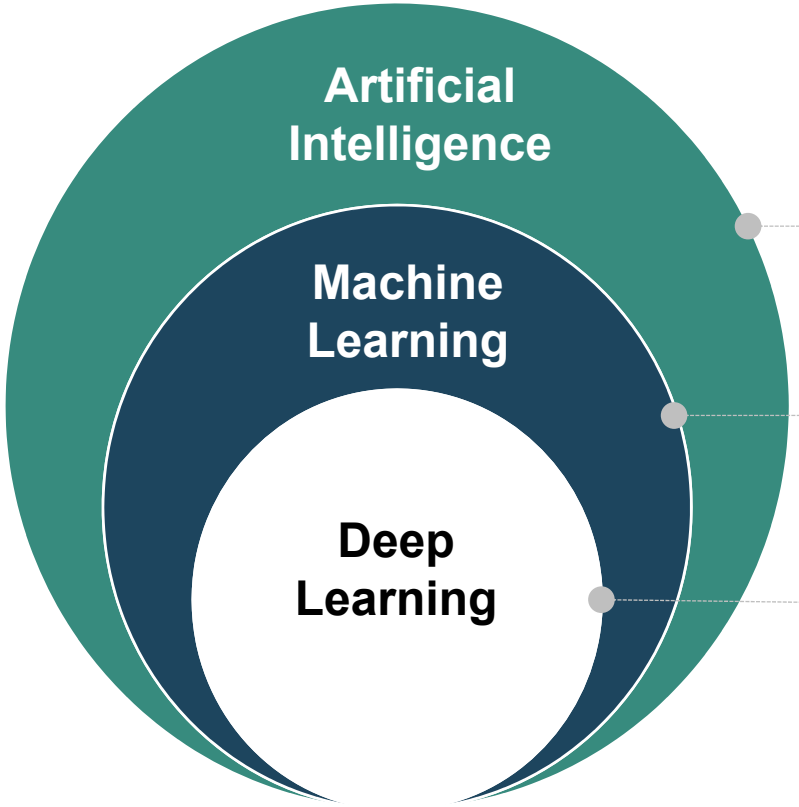


Source: Frost & Sullivan

15 Mins Break

bit.ly/top10_2020

Definition

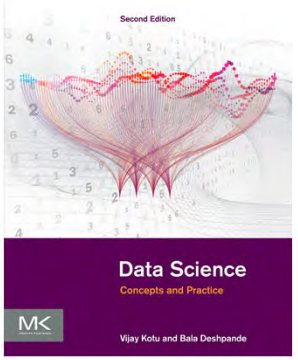


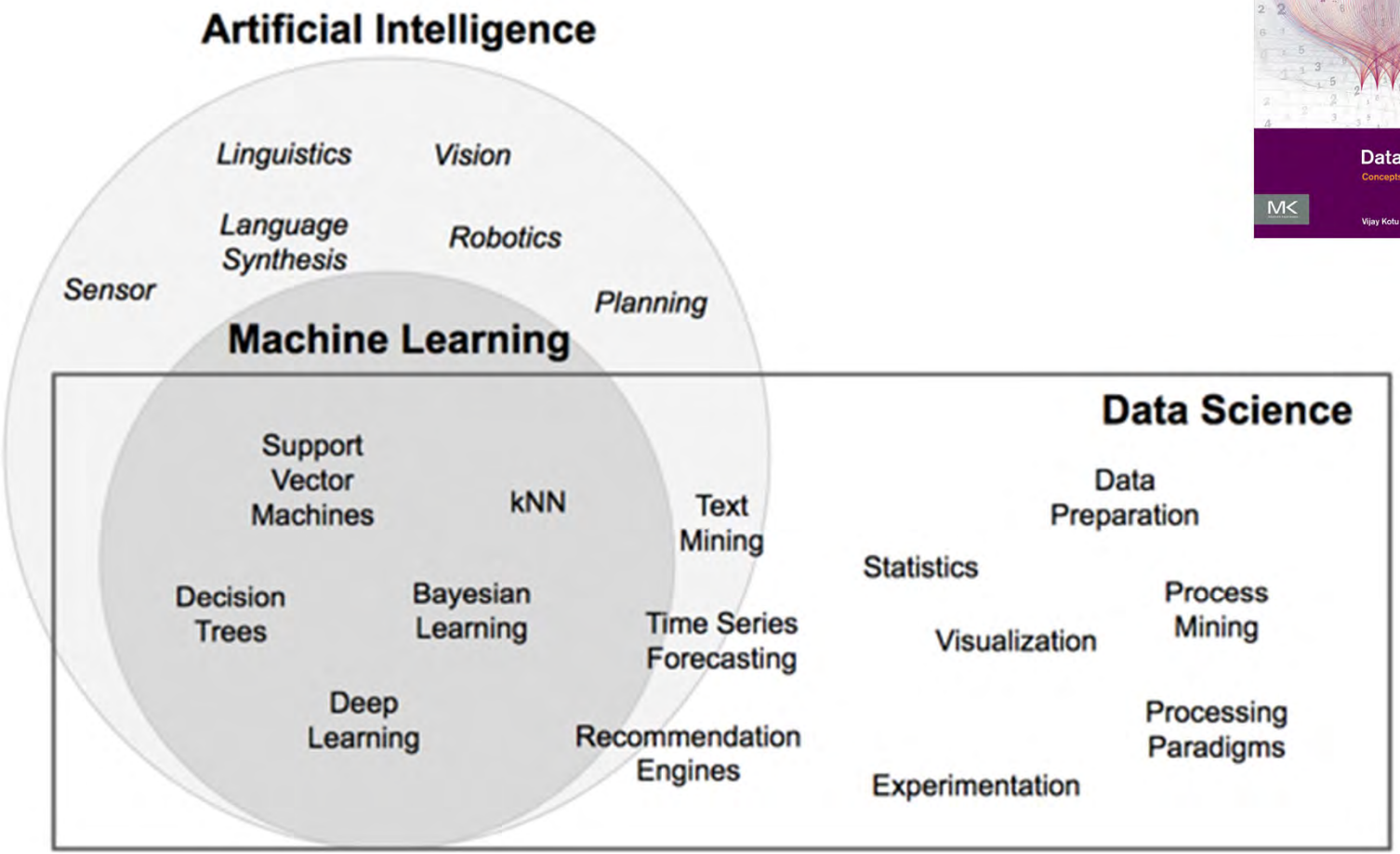
Artificial Intelligence
Any technique which enables computers to sense, reason, act and adapt

Machine Learning
Subset of AI techniques which use statistical methods to enable machines to improve with experiences.

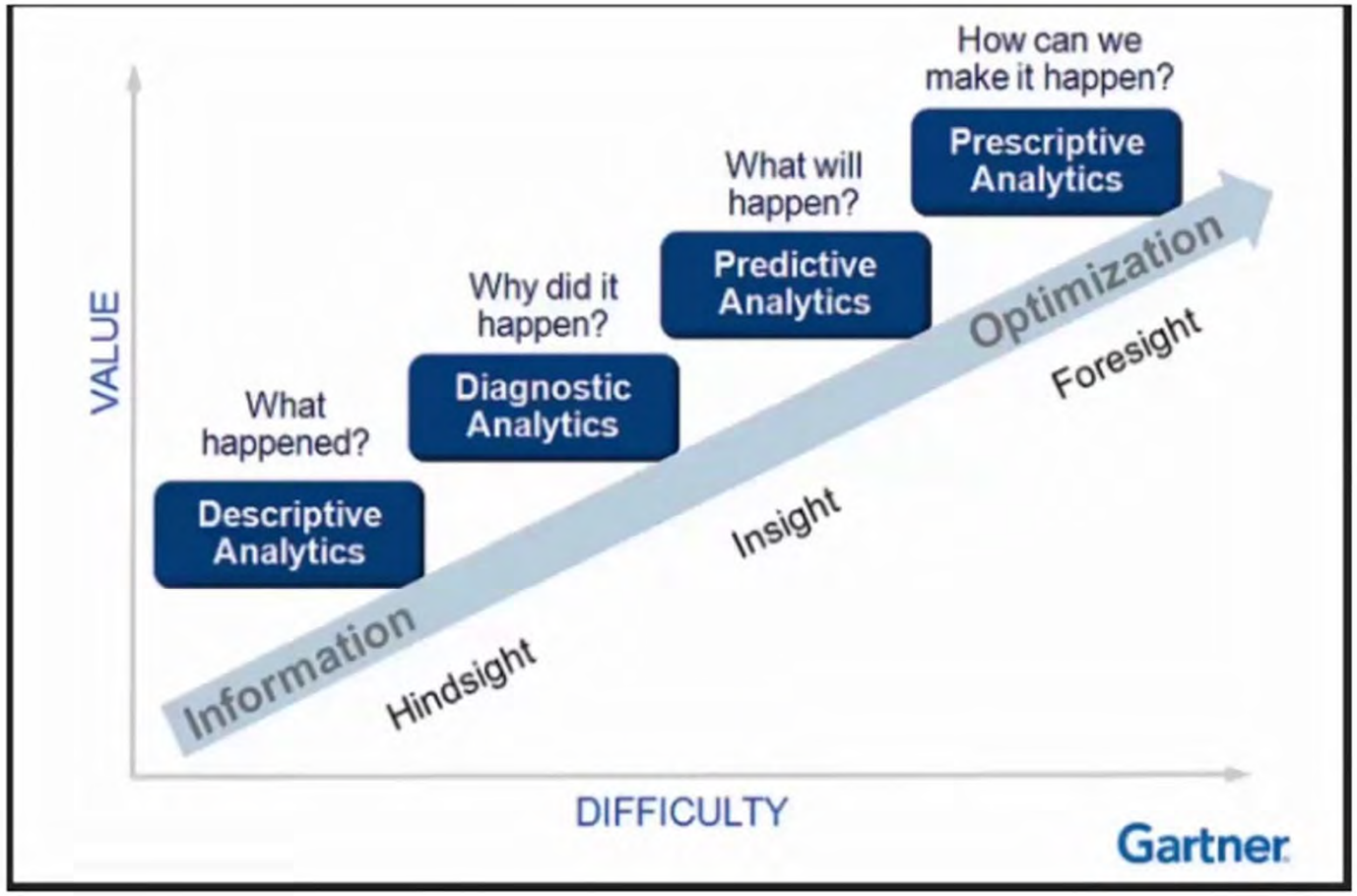
Deep Learning
A subset of machine learning in which multilayered neural networks learn from vast amount of data.

AI vs ML vs DS


Second Edition
Data Science
Concepts and Practice
MK
Vijay Kotu and Bala Deshpande


Artificial Intelligence
Linguistics
Vision
Language Synthesis
Robotics
Sensor
Planning
Machine Learning
Support Vector Machines
kNN
Text Mining
Decision Trees
Bayesian Learning
Time Series Forecasting
Deep Learning
Recommendation Engines
Data Science
Data Preparation
Statistics
Process Mining
Visualization
Processing Paradigms
Experimentation

Gartner Analytic Continuum



5 questions data science answers

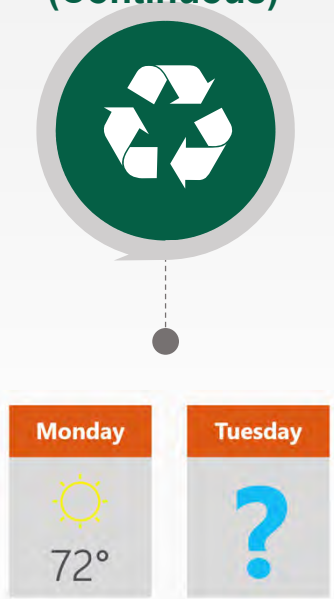
Is this weird? (Anomaly detection)

Is this pressure gauge reading normal?
Is this message from the internet typical?

Is this A or B? (Classification) (discrete values)

Will this tire fail in the next 1,000 miles: Yes or no?
Which brings in more customers: a $5 coupon or a 25% discount?

How many? How Much? (Regression) (Continuous)

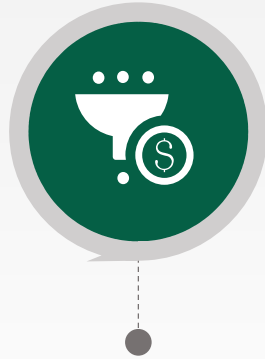


What will the temperature be next Tuesday?
What will my fourth quarter sales be?

How is this organized? (Clustering)

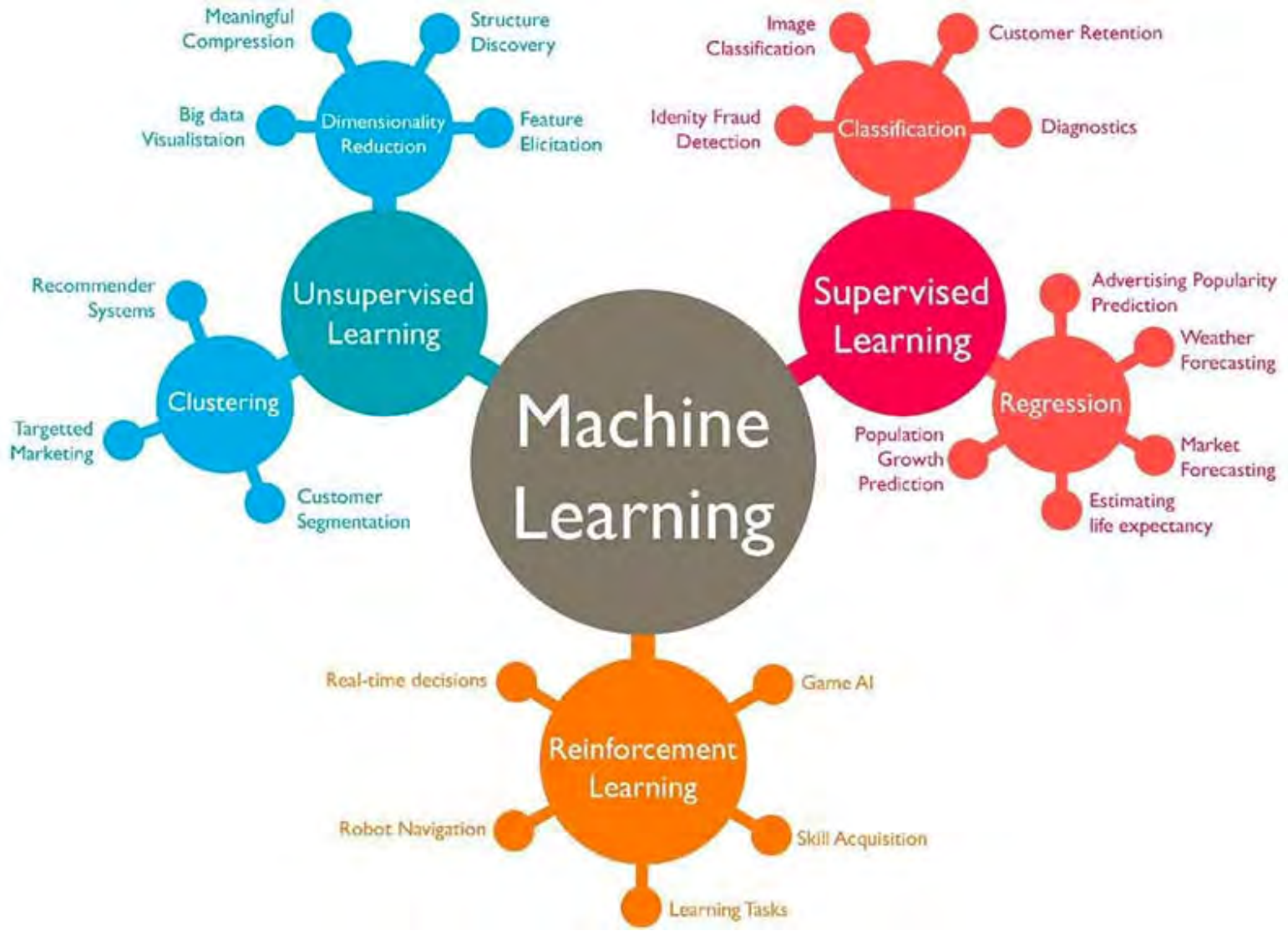
Which viewers like the same types of movies?
Which printer models fail the same way?

What should I do? (Reinforce Learning)

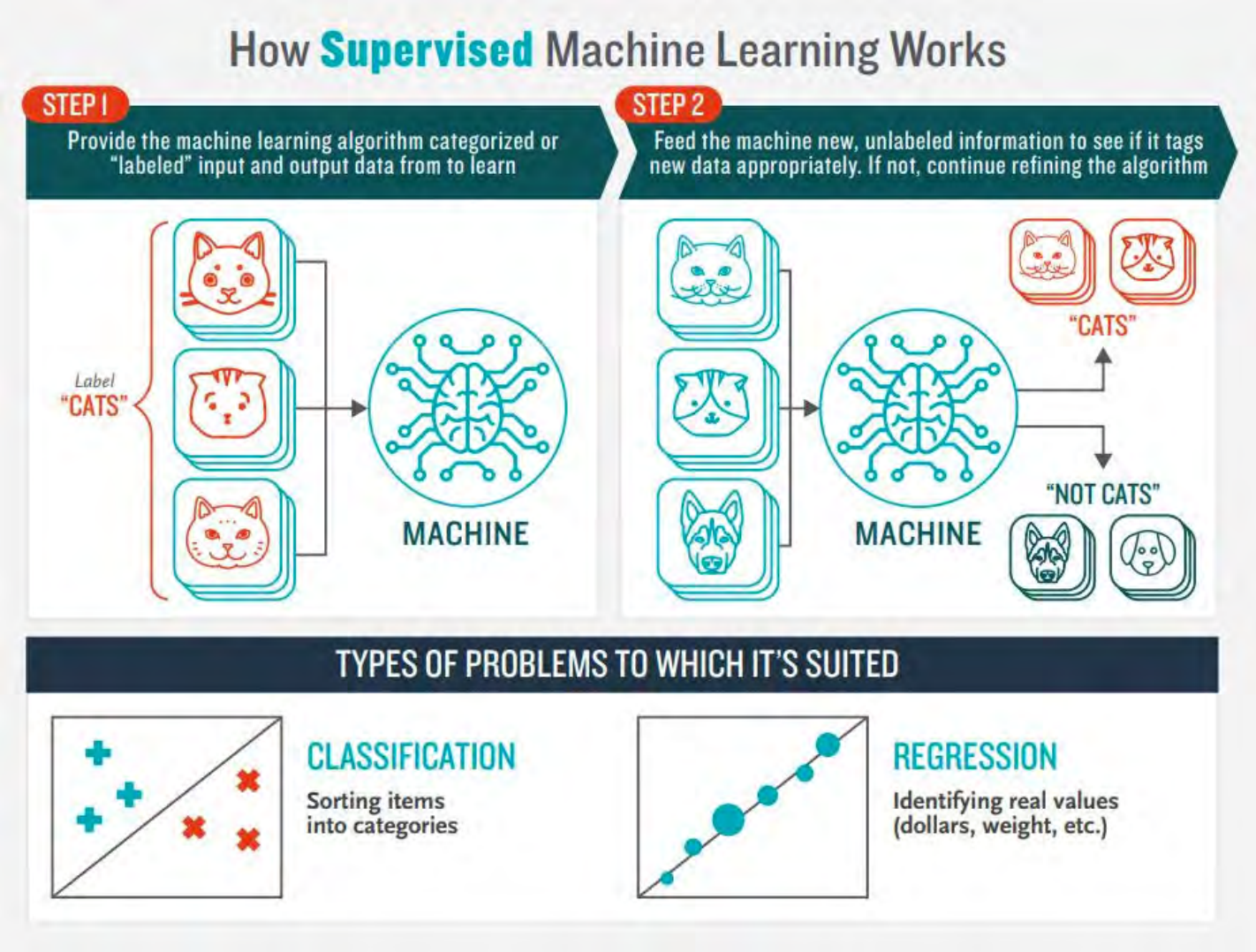


If I'm a self-driving car: At a yellow light, brake or accelerate?
For a robot vacuum: Keep vacuuming, or go back to the charging station?

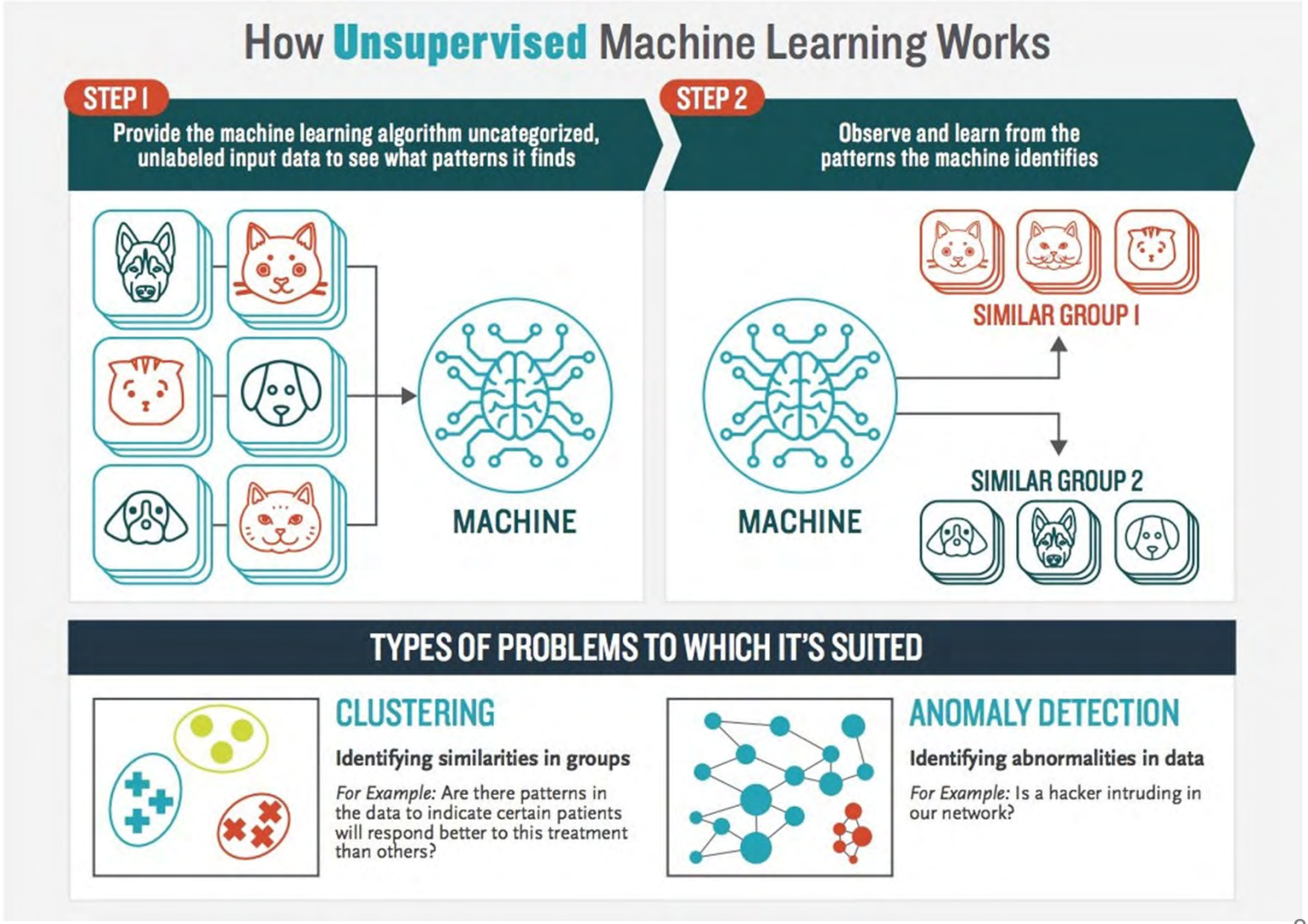
Types of Machine Learning



Supervised Learning



Unsupervised Learning



Machine Learning Example

- Suppose you wanted to identify fraudulent credit card transactions.
- You could define features to be:
  - Transaction time
  - Transaction amount
  - Transaction location
  - Category of purchase
- The algorithm could learn what feature combinations suggest unusual activity.

Machine Learning Limitations

- Suppose you wanted to determine if an image is of a cat or a dog.
- What features would you use?
- This is where **Deep Learning** can come in.

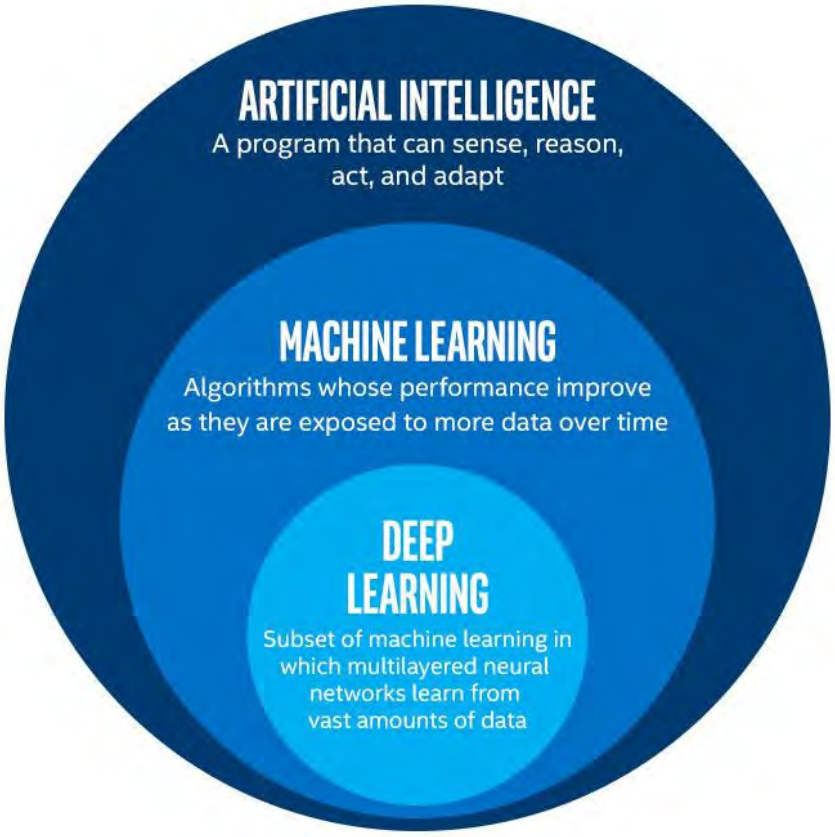
Dog and cat recognition

What is deep learning?

Deep Learning

"Machine learning that involves using very complicated models called "deep neural networks"." (Intel)

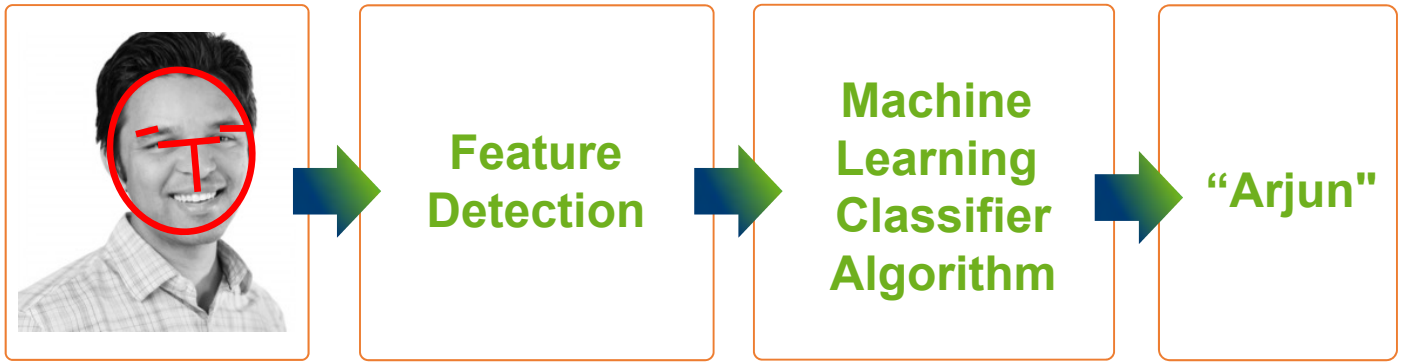
Models determine best representation of original data; in classic machine learning, humans must do this.



Deep Learning Example

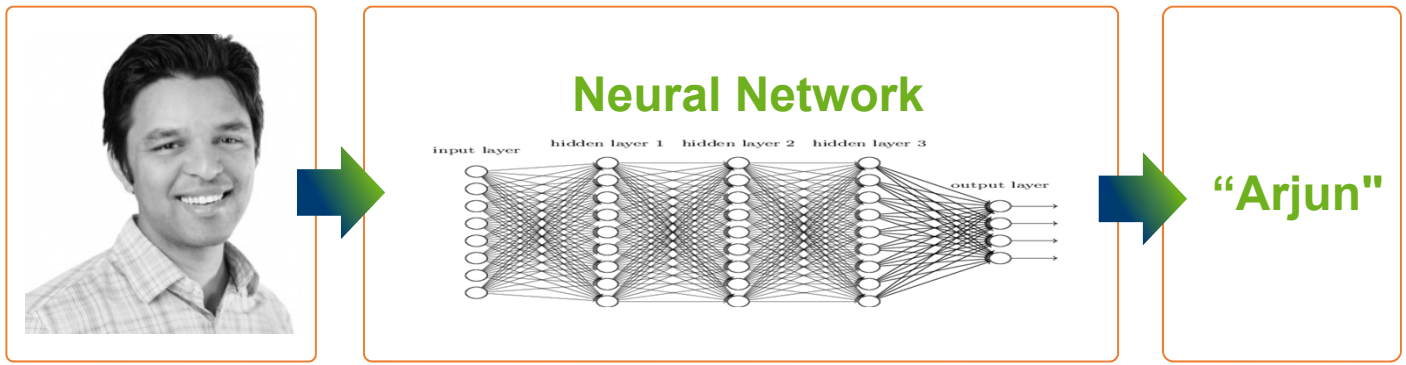
Classic Machine Learning

Step 1: Determine features.
Step 2: Feed them through model.



Deep Learning

Steps 1 and 2 are combined into 1 step.



Deep Learning in Action

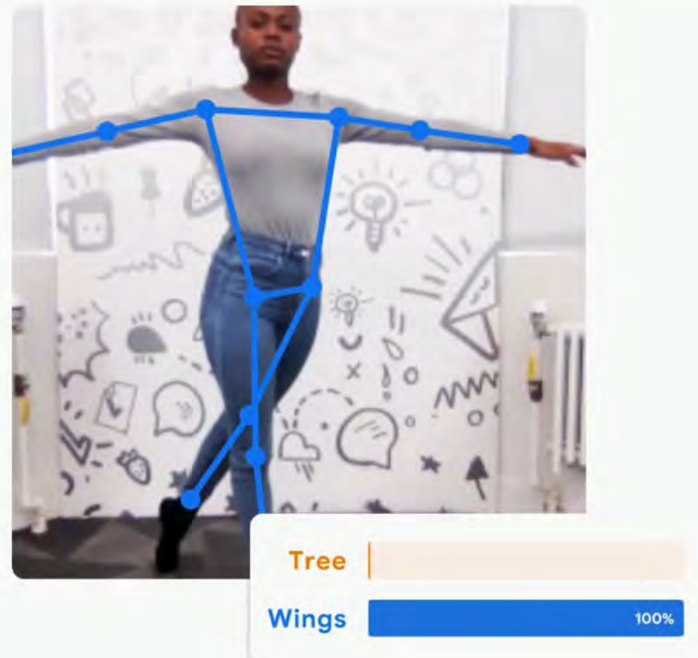
10 mins

bit.ly/google_teachable

Teachable Machine

Train a computer to recognize your own images, sounds, & poses.

A fast, easy way to create machine learning models for your sites, apps, and more – no expertise or coding required.



Get Started

p5.js Coral node

Deep Learning Problem Types

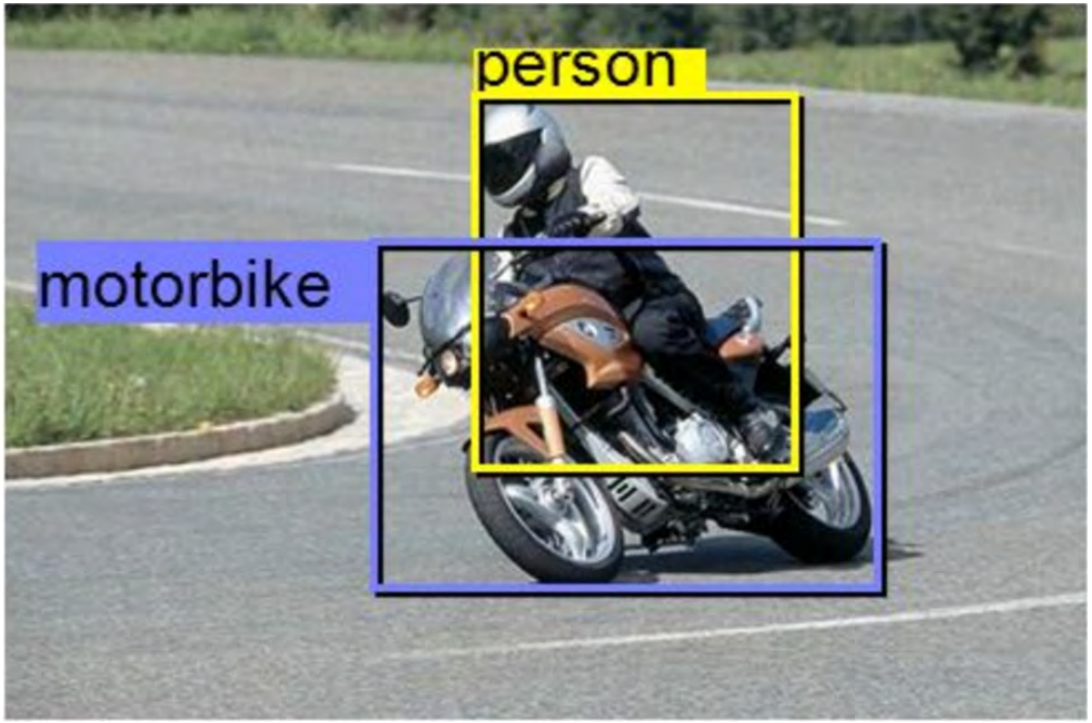
Deep Learning can solve multiple supervised and unsupervised problems.

- The majority of its success has been when working with images, natural language, and audio data.
- Image classification and detection.
- Semantic segmentation.
- Natural language object retrieval.
- Speech recognition and language translation.

Classification and Detection

Detect and label the image

- Person
- Motor Bike



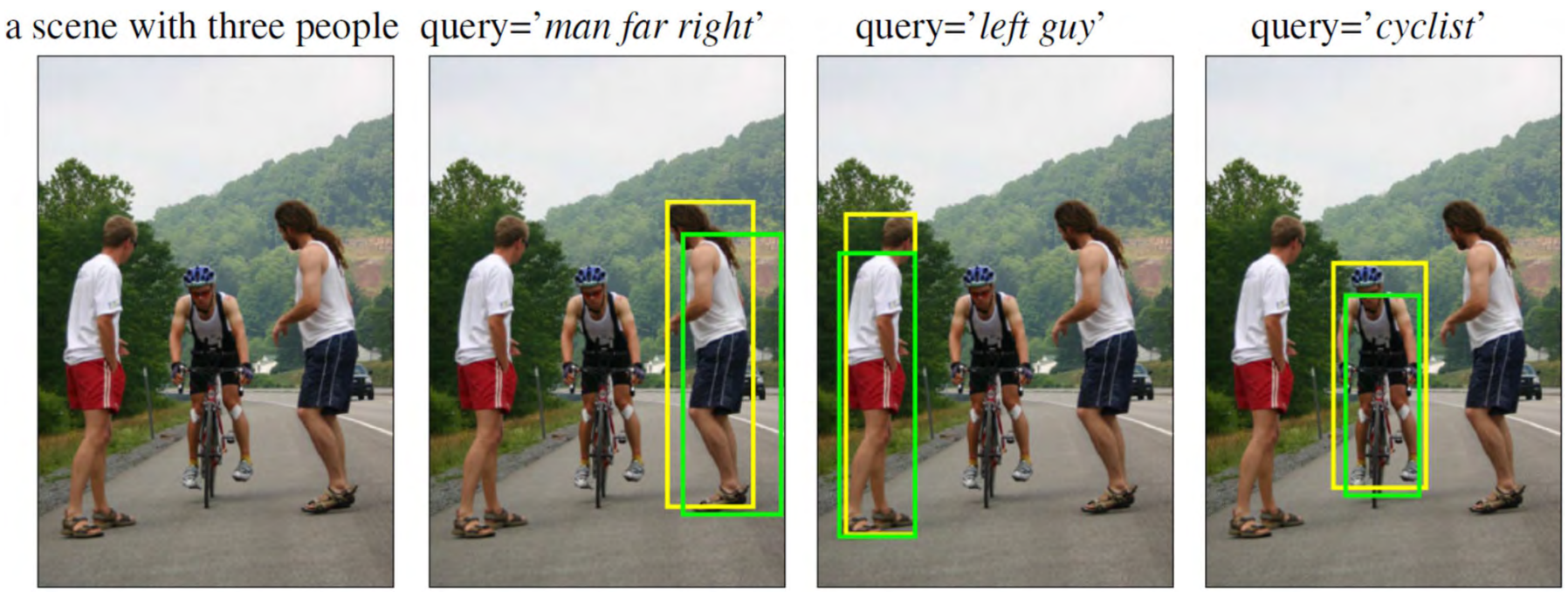
https://people.eecs.berkeley.edu/~jhoffman/talks/lsda-baylearn2014.pdf

Semantic Segmentation

Label every pixel

https://people.eecs.berkeley.edu/~jhoffman/talks/lsda-baylearn2014.pdf

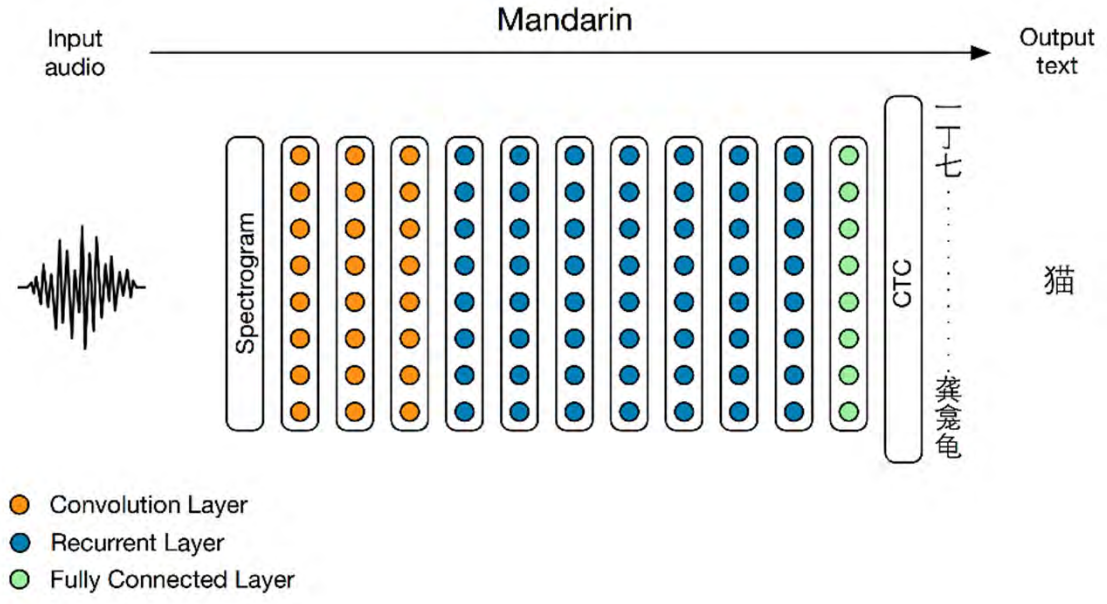
Natural Language Object Retrieval



http://arxiv.org/pdf/1511.04164v3.pdf

Speech Recognition and Language Translation

The same architecture can be used for speech recognition in English, or in Mandarin Chinese.



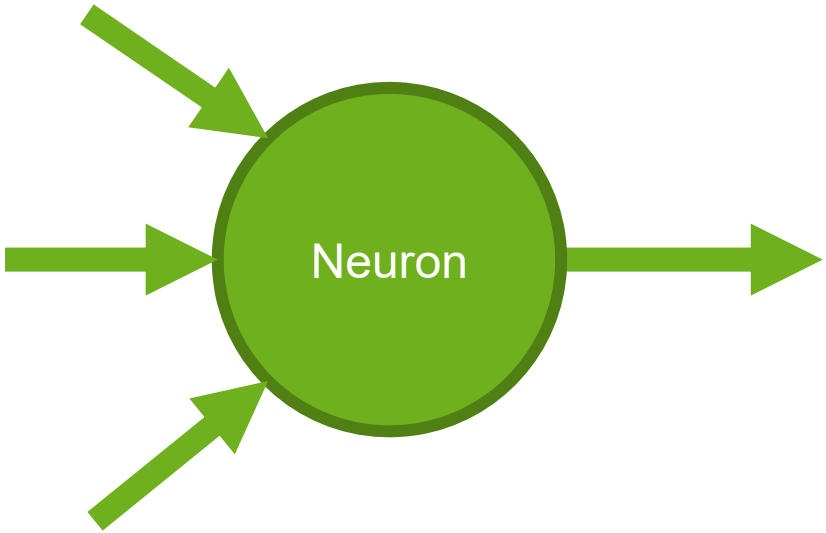
http://svail.github.io/mandarin/

What is neural network?

Which model?

There are many models that represent the problem and make decisions in different ways, each with their own advantages and disadvantages.

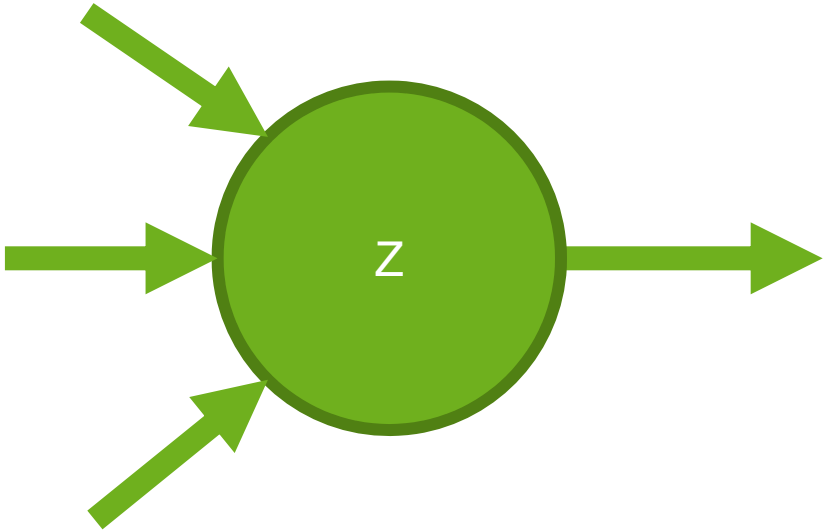
- DL models are biologically inspired.
- The main building block is a **neuron**.



Neuron

A neuron multiplies each feature by a **weight** and then adds these values together.

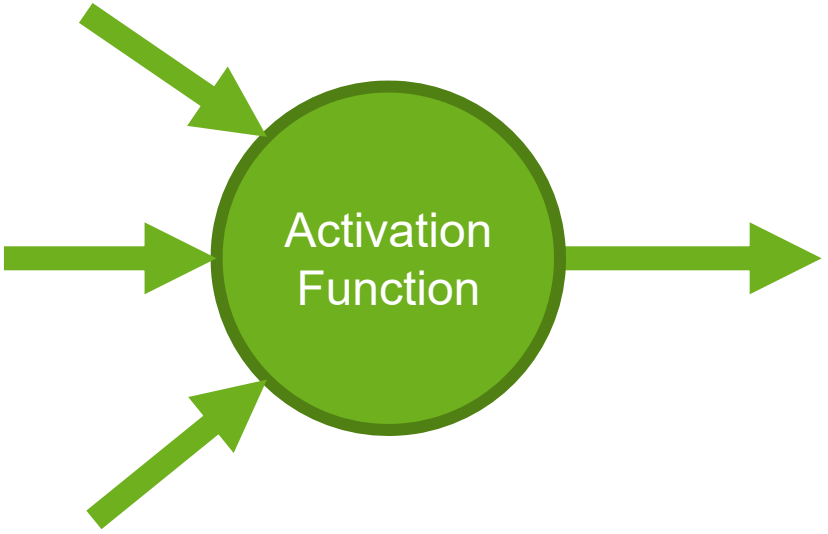
- $Z = X_1W_1 + X_2W_2 + X_3W_3$



Neuron

This value is then put through a function called the **activation function.**

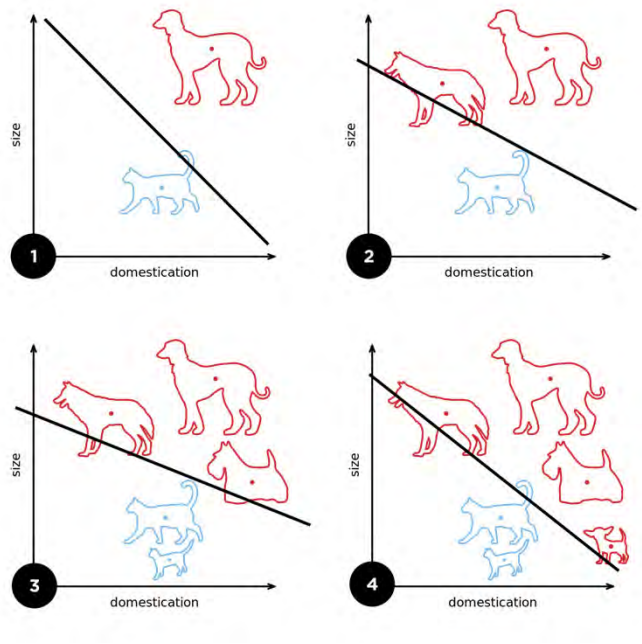
- There are several activation functions that can be used.
- The output of the neuron is the output of the activation function.



Perceptron

A neuron with a simple activation function can solve **linearly separable** problems.

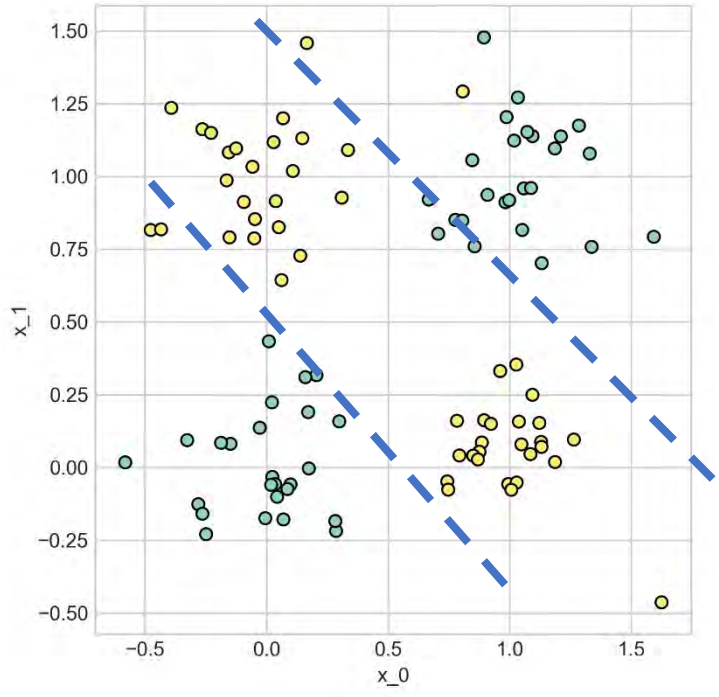
- These are problems where the different classes can be separated by a line.
- **The Perceptron**: one of the earliest neural network models that used neurons with simple activation functions.



Perceptron

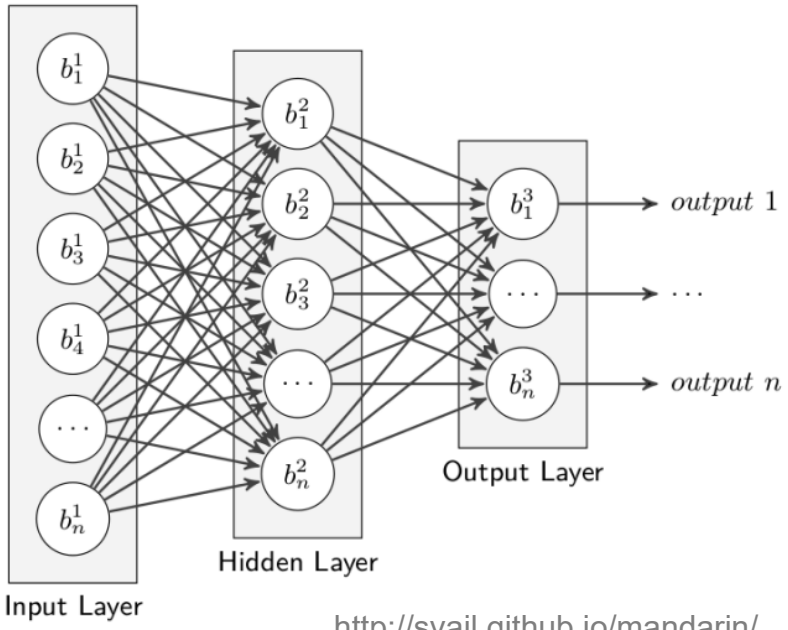
Problems where the labels cannot be separated by a single line are not solvable by a single neuron.

- This is a major limitation, and one of the reasons for the first AI winter, that was discussed earlier.



Fully Connected Network

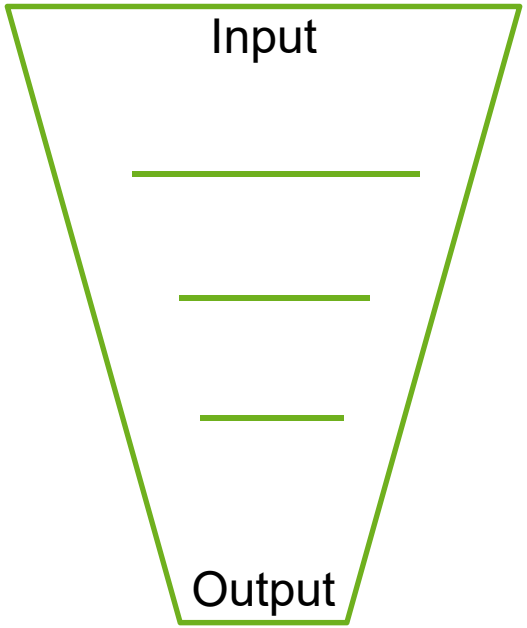
- More complicated problems can be solved by connecting multiple neurons together and using more complicated activation functions.
- Organized into **layers** of neurons.
- Each neuron is connected to every neuron in the previous layer.
- Each layer transforms the output of the previous layer and then passes it on to the next.
- Every connection has a separate weight.



http://svail.github.io/mandarin/

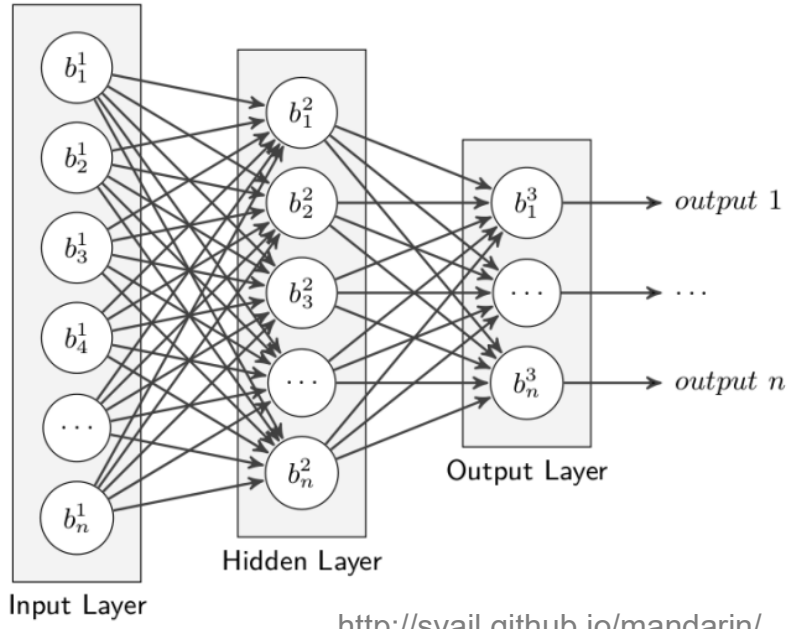
Deep Learning

- Deep Learning refers to when many layers are used to build **deep networks**.
- State-of-the-art models use hundreds of layers.
- Deep layers tend to decrease in width.
- Successive layers transform inputs with two effects:
- **Compression**: each layer is asked to summarize the input in a way that best serves the task.
- **Extraction**: the model succeeds when each layer extracts task-relevant information.



Steps in Building a Fully Connected Network

- To build a fully connected network a user needs to:
- Define the network architecture.
- How many layers and neurons?
- Define what activation function to use for each neuron.
- Define an evaluation metric.
- The values for the weights are learned during model training.



http://svail.github.io/mandarin/

Evaluation Metric

The metric used will depend on the problem being solved. Some examples include:

- Regression
  - Mean Squared Error
- Classification
  - Categorical Cross-Entropy
- Multi-Label classification
  - Binary Cross-Entropy

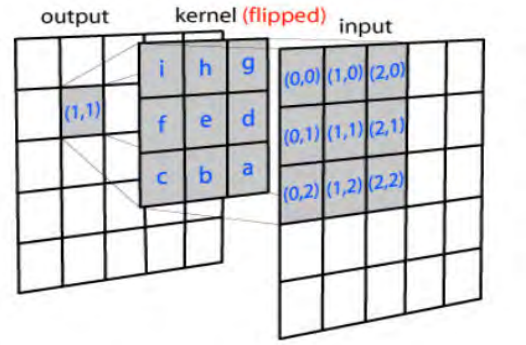
Fully Connected Network Problems

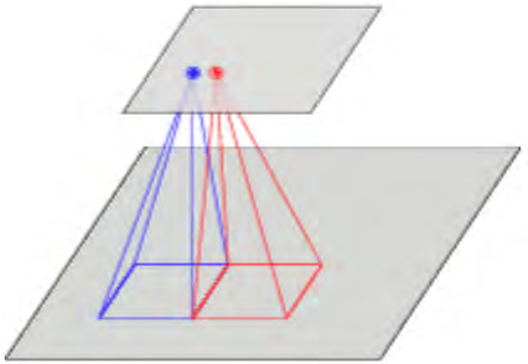
Not optimal for detecting features.

- Computationally intensive – heavy memory usage.

Convolutional Neural Network

- **Convolutional neural networks** reduce the required computation and are good for detecting features.
- Each neuron is connected to a small set of nearby neurons in the previous layer.
- The same set of weights are used for each neuron.
- Ideal for spatial feature recognition.
  - Example: image recognition
- Cheaper on resources due to fewer connections.





http://svail.github.io/mandarin/

Convolutions as Feature Detectors

Convolutions can be thought of as “local feature detectors”.

Vertical Line Detector

-1	1	-1
-1	1	-1
-1	1	-1

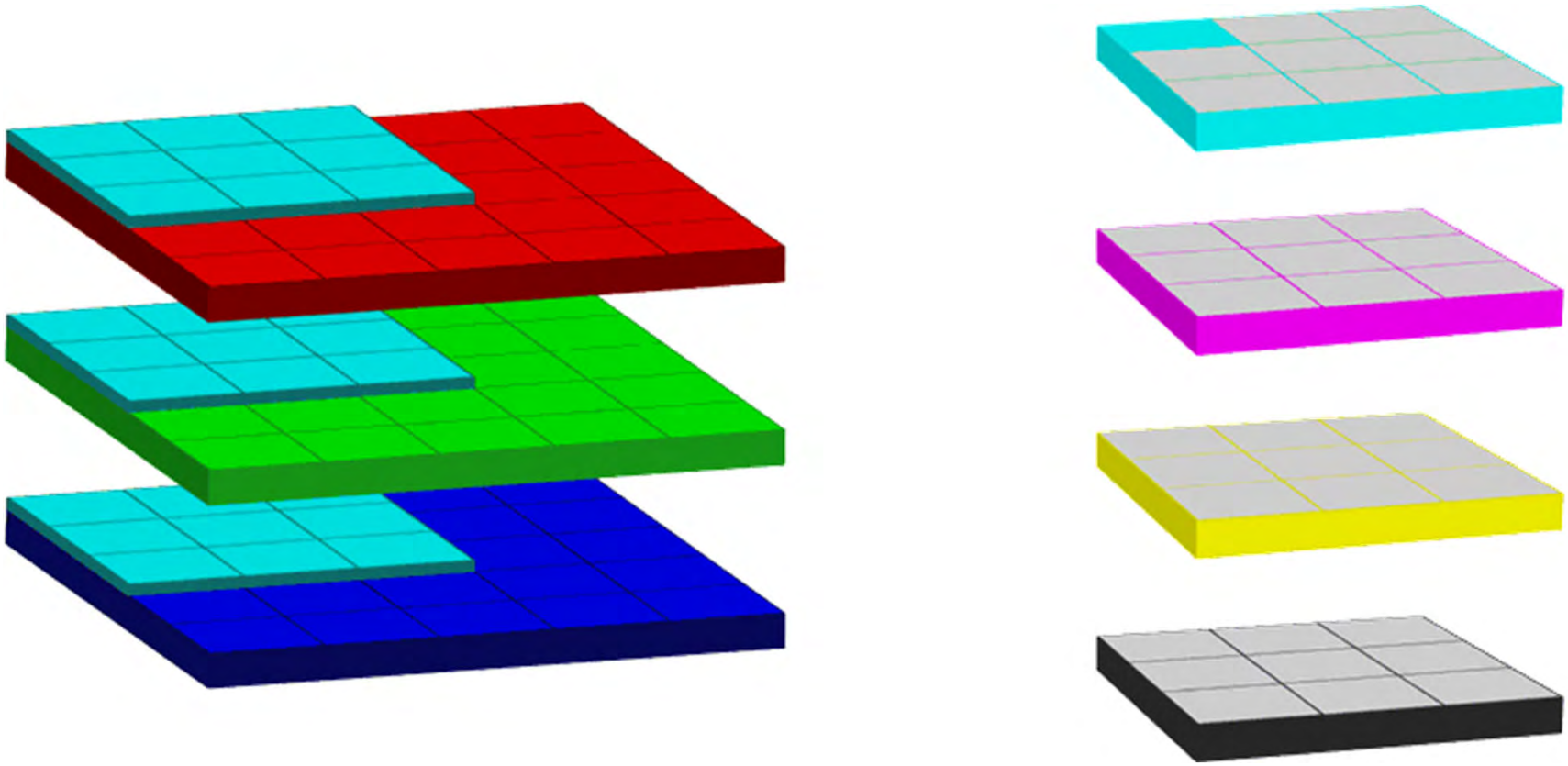
Horizontal Line Detector

-1	-1	-1
1	1	1
-1	-1	-1

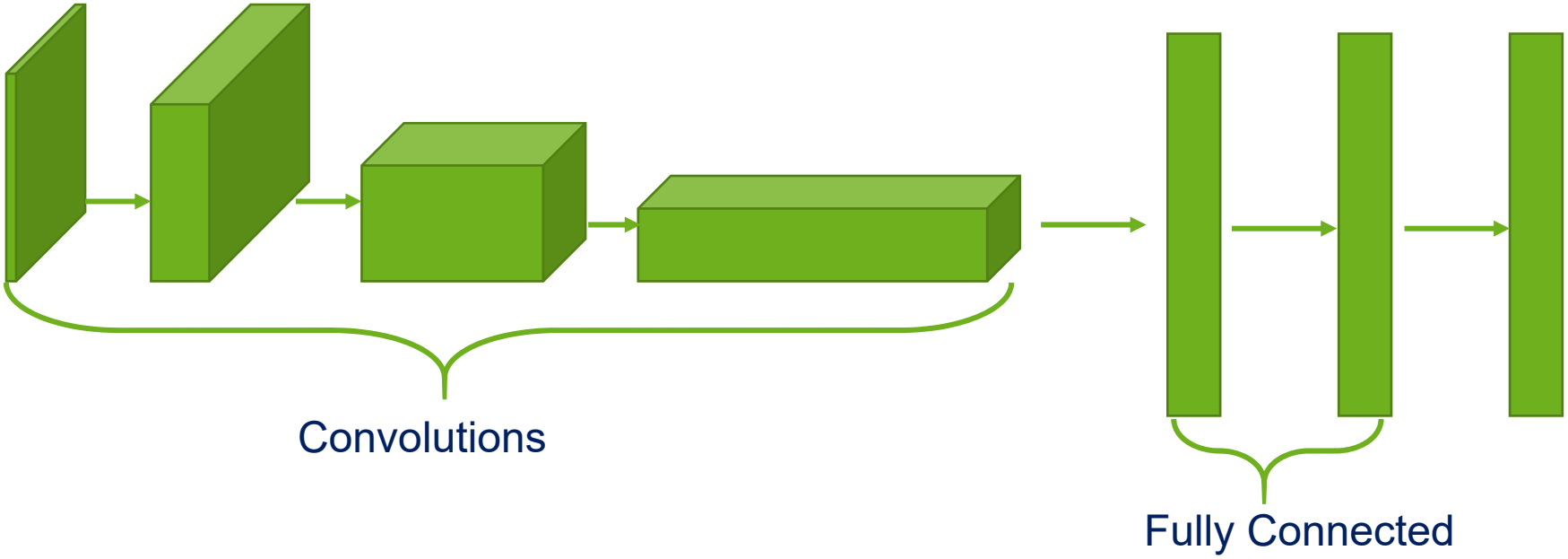
Corner Detector

-1	-1	-1
-1	1	1
-1	1	1

Convolutions



Convolutional Neural Network

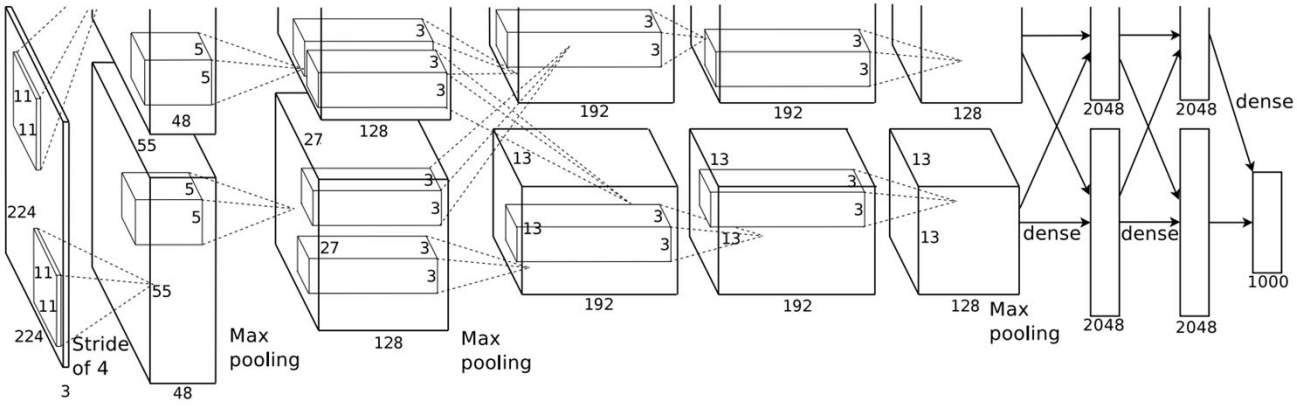


Common Architectures

- AlexNet
- VGG
- Inception
- MobileNets

AlexNet

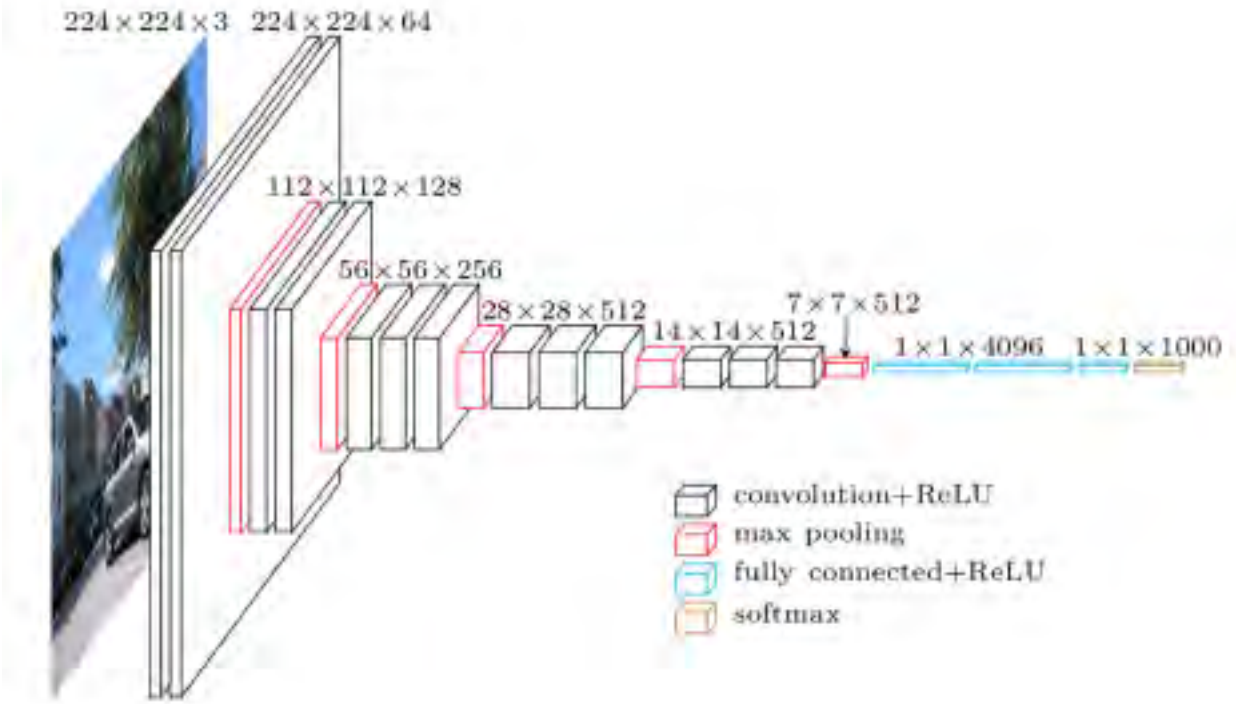
- Created in 2012 for the ImageNet Large Scale Visual Recognition Challenge (ILSVRC)
- Task: predict the correct label from among 1000 classes
- Dataset: around 1.2 million images
- Considered the “flash point” for modern deep learning
- Demolished the competition.
- Top 5 error rate of 15.4%
- Next best: 26.2%



VGG

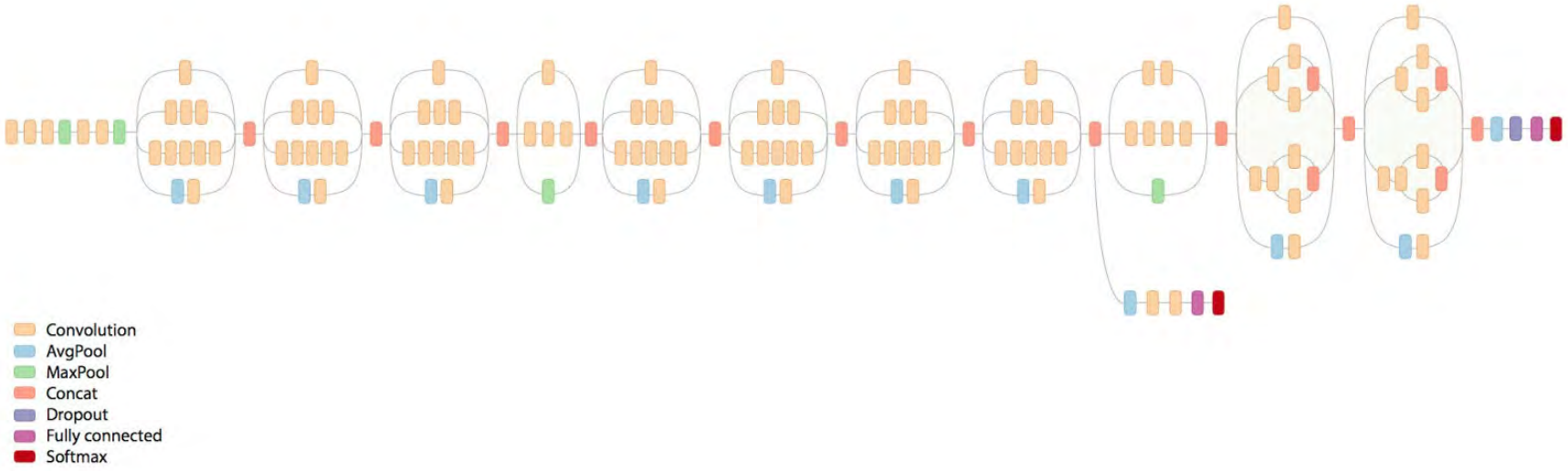
- Simplify Network Structure
- Avoid Manual Choices of Convolution Size
- Very Deep Network with 3x3 Convolutions
- These “effectively” give rise to larger convolutions

Reference:
Very Deep Convolutional Networks for Large-Scale Image Recognition
Karen Simonyan and Andrew Zisserman, 2014



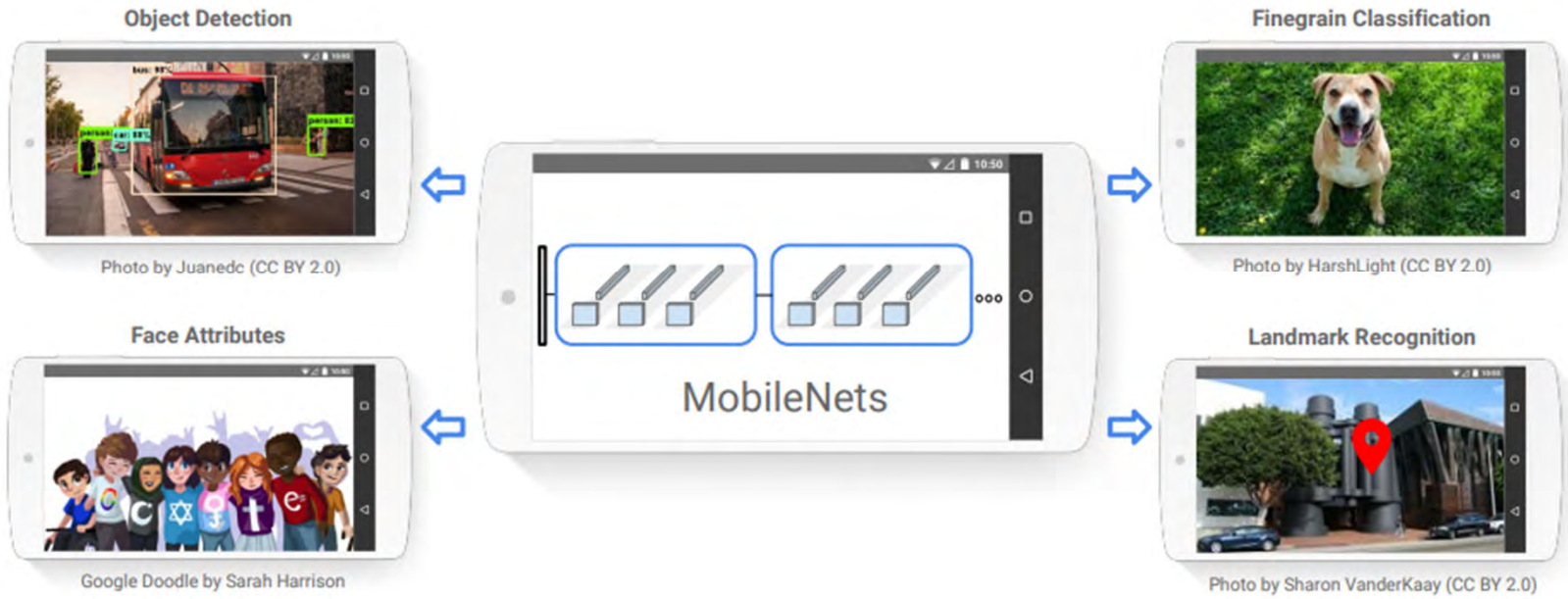
Inception

- Szegedy et al 2014
- Idea: network would want to use different receptive fields
- Solution: Turn each layer into branches of convolutions
- Each branch handles smaller portion of workload
- Concatenate different branches at the end



MobileNets

- Efficient models for mobile and embedded vision applications.



MobileNet models can be applied to various recognition tasks for efficient device intelligence.

Pre-trained CNN models

- Models for image classification with weights trained on ImageNet:
  - Xception
  - VGG16
  - VGG19
  - ResNet, ResNetV2
  - InceptionV3
  - InceptionResNetV2
  - MobileNet
  - MobileNetV2
  - DenseNet
  - NASNet
  - EfficentNet

https://keras.io/api/applications/

Recurrent Neural Network

Issue: Variable length sequences of words

- With images, we forced them into a specific input dimension
- Not obvious how to do this with text.
- For example, classify tweets as positive, negative, or neutral.
- Tweets can have a variable number of words.
- What to do?

Recurrent Neural Network

Issue: Ordering of words is important

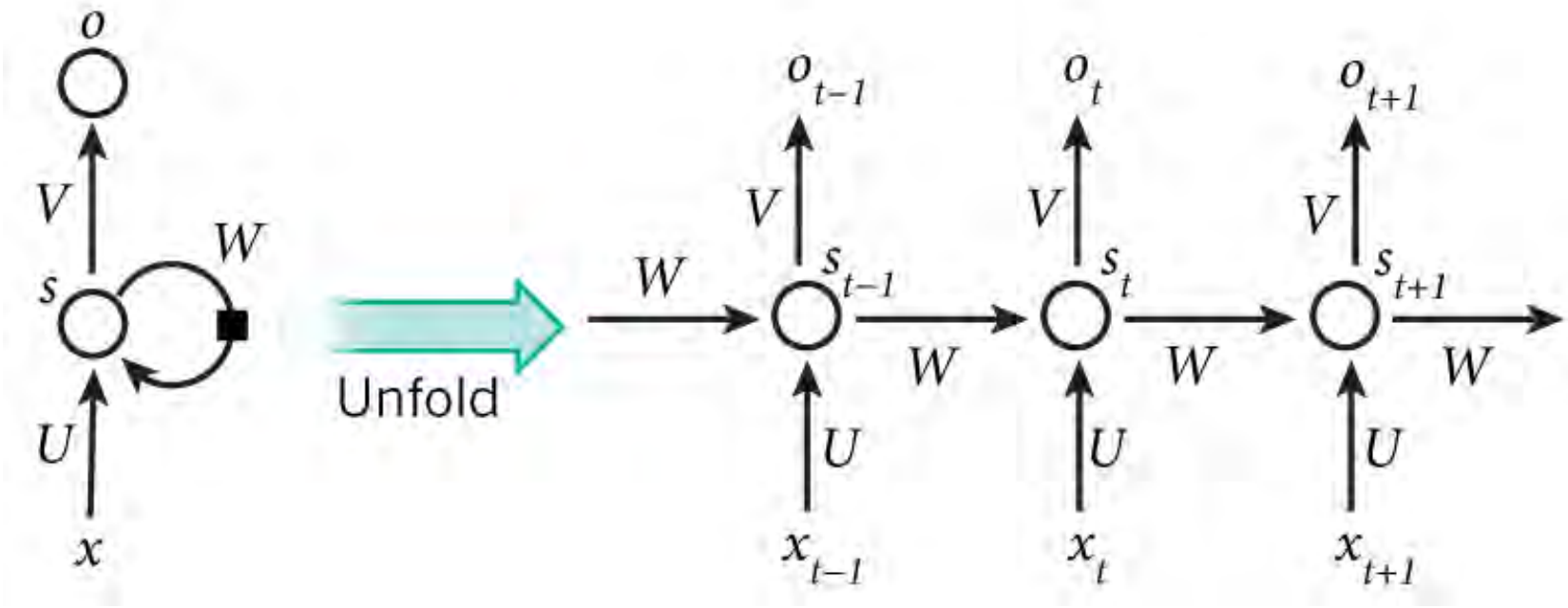
- Want to do better than “bag of words” implementations
- Ideally, each word is processed or understood in the appropriate context.
- Need to have some notion of “context”.
- Words should be handled differently depending on “context”
- Also, each word should update the context.

Recurrent Neural Network

Idea: Use the notion of "recurrence"

- Input words one by one
- Network outputs two things:
  - Prediction: What would be the prediction if the sequence ended with that word
  - State: Summary of everything that happened in the past
- This way, can handle variable lengths of text
- The response to a word depends on the words that preceded it.

Recurrent Neural Network



Recurrent Neural Network

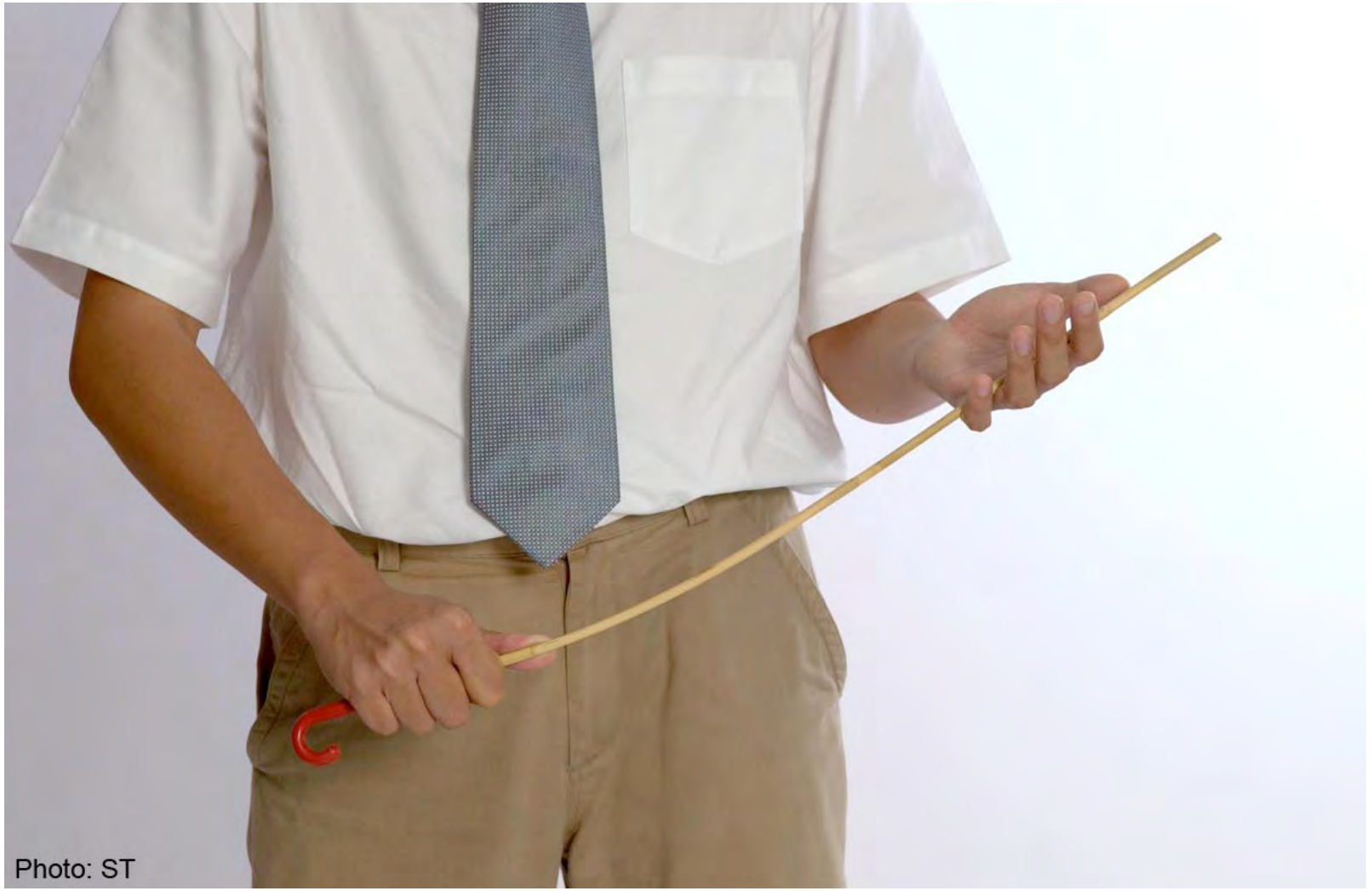
- For text/words as application.
- But, RNNs can be used for other sequential data
  - Time-Series Data
  - Speech Recognition
  - Sensor Data
  - Genome Sequences

- Nature of state transition means it is hard to keep information from distant past in current memory without reinforcement.

- **In real life, implementing RNN is hard. A more practical implementation is called Long Short-Term Memory (LSTMs), which have a more complex mechanism for updating the state.**

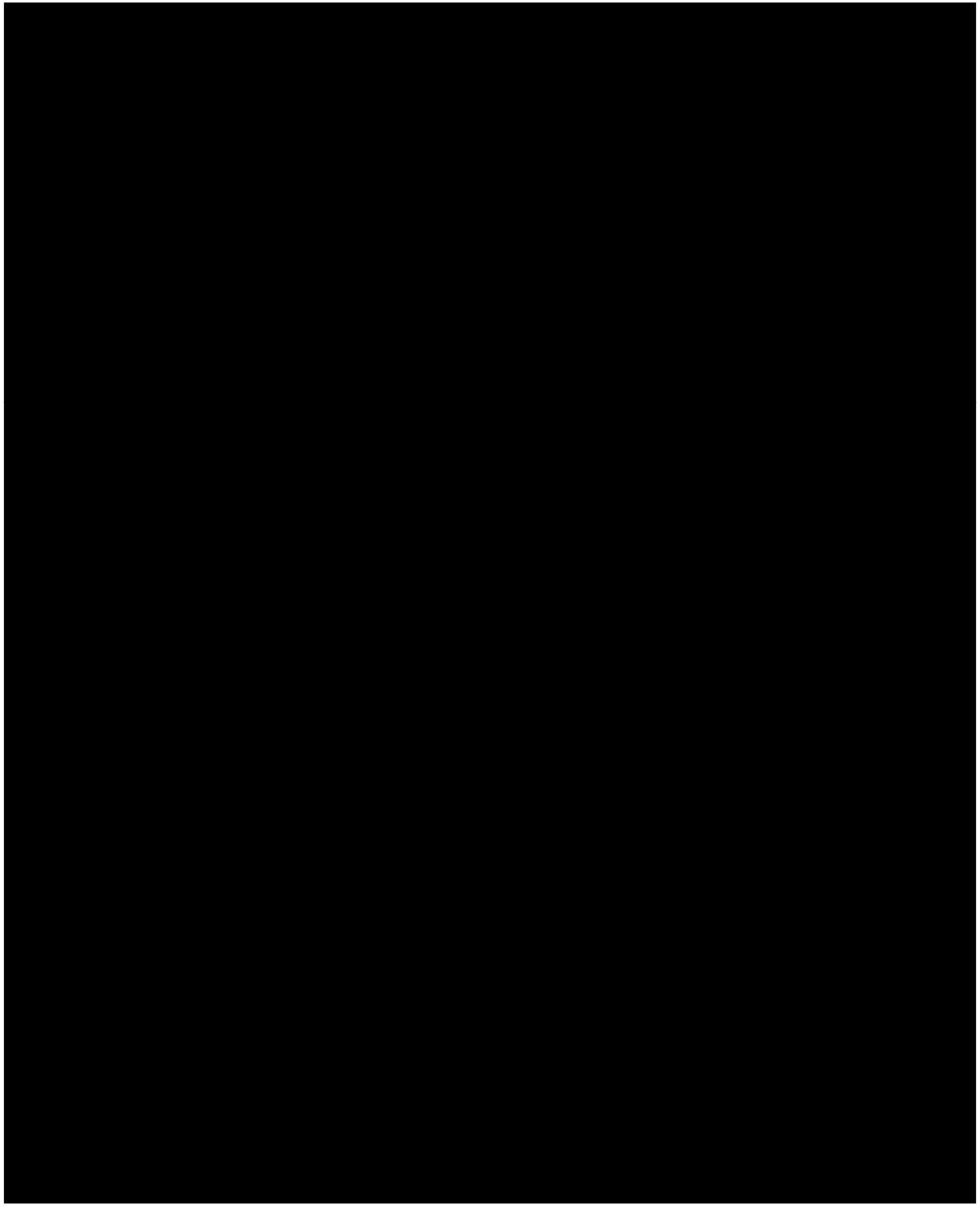
What is a CNN?

Reinforcement Learning

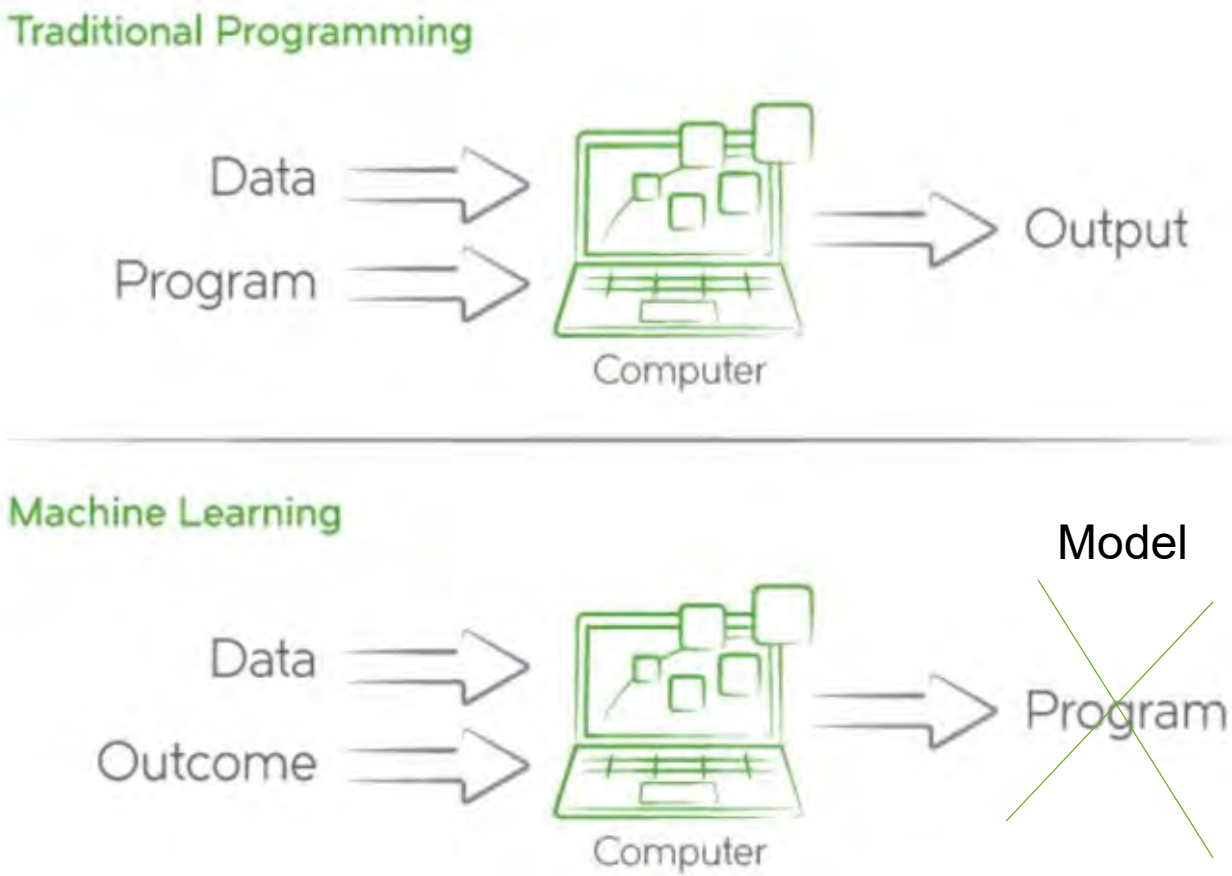


Source: Practical Reinforcement Learning

Reinforcement Learning



Traditional Programming vs Machine Learning



Quiz

Step 1: Scan the following QR code
Get ready for the quiz to start

https://bit.ly/kw_poll

Step 2: Enter your name you would like to appear alongside your responses.

Step 3: Wait for the quiz to begin…

60 mins Lunch Break

Some interesting videos

https://www.youtube.com/watch?v=bmNaLtC6vkU

https://www.youtube.com/watch?v=Nnf8P5A_saE

AI Software

As datasets get bigger the need for optimized software becomes increasingly important.

- The computation required increases with the size of the dataset.
- Software needs to be optimized for the underlying hardware to take full advantage of faster computers.
- The software and hardware need to be optimized for specific mathematical operations for optimal performance.

AI Software

It is usually inefficient for AI developers to write software to manage and analyze this data themselves.

- Developing software optimized for hardware and mathematical operations is time consuming.
- As methods become increasingly sophisticated the code for mathematics become more error prone.

AI Developer

An AI developer needs to leverage existing code so they can focus on the big picture and overall system framework.

- Use code that's optimized for the underlying hardware since AI tasks require a large amount of computation to complete.
- Simplify model development and training by providing high-level primitives for complex and error-prone mathematical transformations.
- Understand and use algorithms by stringing together API calls.
- Take advantage of software libraries and frameworks.

AI Frameworks

A **software framework** provides generic functionality that can act as a skeleton architecture to accomplish a particular task.

- A framework dictates the flow of control and defines the overall nature of the program where common design patterns can be reused.
- Frameworks can be extended by the users to provide specific functionality and customizations.
- Frameworks provide a standard way to build and deploy applications.
- Multiple frameworks can use the same underlying libraries.

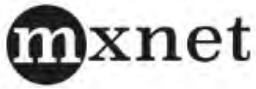
Deep Learning Frameworks

Deep Learning frameworks vary in their level of functionality.

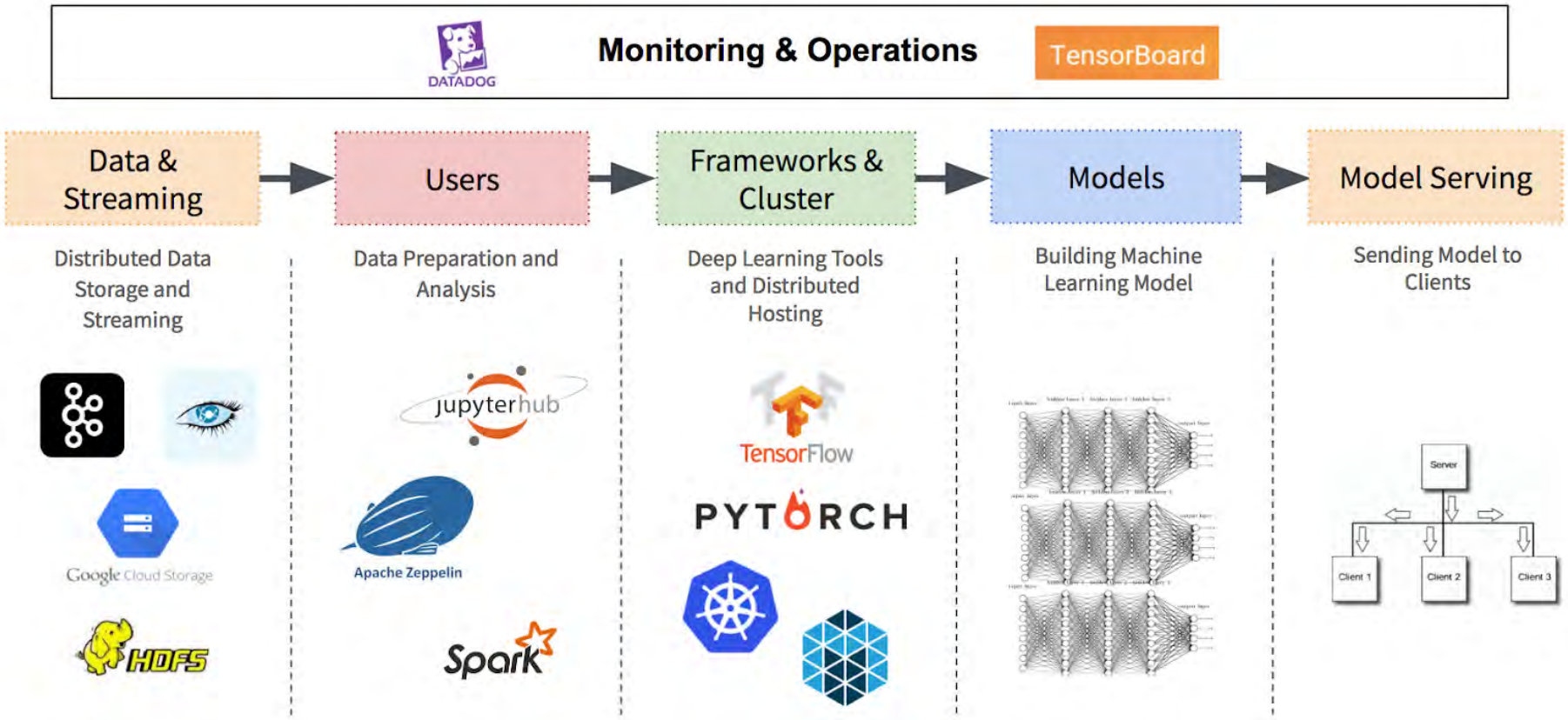
- Some allow you to define a neural network of arbitrary complexity from the most basic building blocks
- Others act as drivers or wrappers aimed at boosting developer productivity but are limited in their functionality due to the higher level of abstraction.

AI frameworks

Frameworks



Deep Learning Pipeline



Tensorflow

TensorFlow*: Python* based DL framework designed for ease of use and extensibility on modern deep neural networks.

- Open-sourced by Google in November 2015.
- As of May 2017, it now integrates optimizations for Intel® Xeon® processors.
- According to technology site KDNuggets*, as of 2018 TensorFlow is the most popular deep learning framework
- Based on defining static computation graphs and then having multidimensional arrays through the graph.

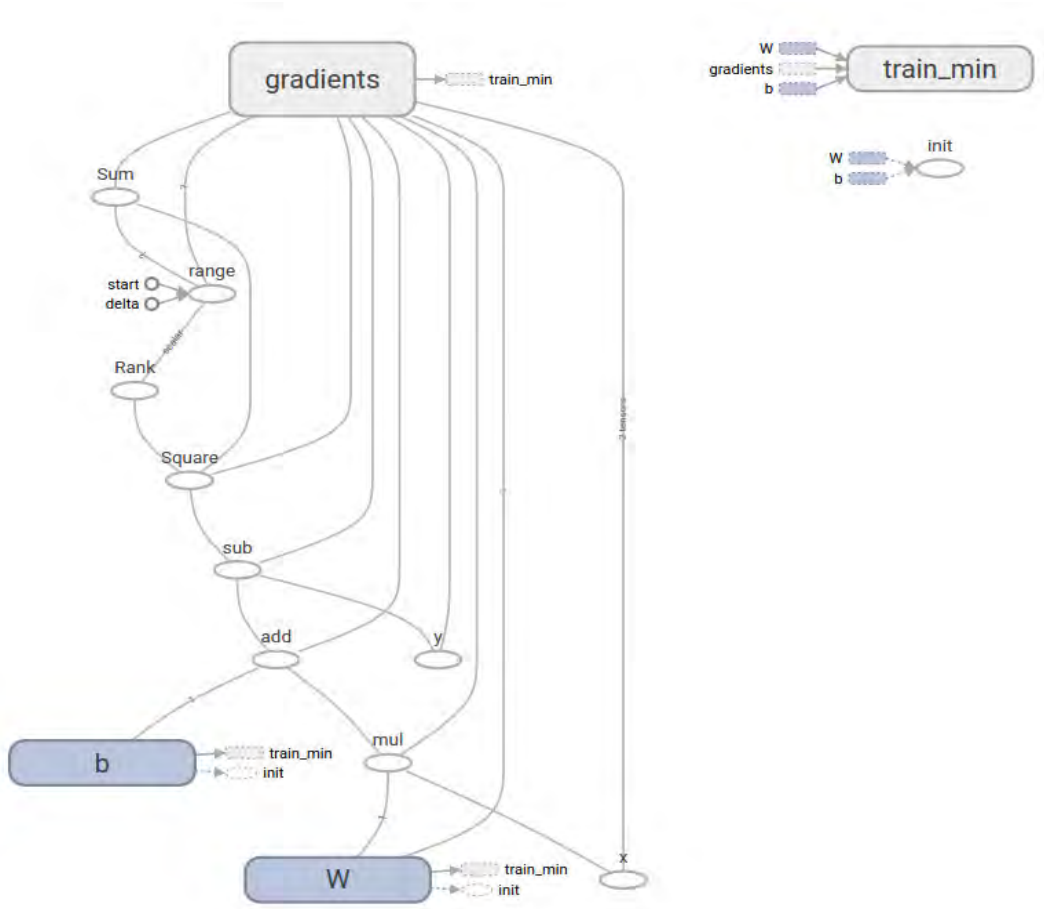
Tensorflow

TensorFlow* is based on the idea of defining static computational graphs and flowing data through them.

- Edges represent numerical data flowing through the graph.
- Nodes represent computations.
- Data is represented as tensors that are typed multidimensional arrays.
- These can be used to represent words, images, or any other data flowing through the network.
- TensorFlow uses “optimizers”, such as gradient descent, Adam, and RMSProp, to train neural networks.

Tensorflow

Computational graph for linear regression. Source: TensorFlow*



Caffe

Caffe* is a deep learning framework written in C++.

- Developed at the University of California Berkeley in 2014.
- Designed to run fast on GPUs, the most popular DL solution at that time.

Caffe

Caffe2

Caffe2* is an open source DL framework announced by Facebook in April 2017 with new features.

- Deployed at Facebook to help researchers train large machine learning models and deliver AI on mobile devices.
- Built with expression, speed, and modularity in mind.

Theano

Theano* is a Python* numerical computation library.

- Developed at the University of Montreal.
- Designed to run fast on GPUs.
- Improved performance on Intel® Xeon® and Intel® Xeon Phi™ processors with this fork of the popular Python library.
- Announced in September 2017 that major development will stop.

MXNet

MXNet* is an open-source, deep learning framework.

- Apache* project originally developed within Carnegie Mellon University.
- Includes built-in support for the Intel® Math Kernel Library (Intel® MKL).
- Now includes Intel, Microsoft, and multiple universities as contributors.
- Characterized by nearly linear scaling with the number of GPUs used (doubling GPUs leads to nearly double the speed).
- Supports both imperative and symbolic programming.

PyTorch

- Python wrapper over Torch (C++ library) released in Jan 2017
- Also stores data and variables as Tensors
- Developed by Facebook and other companies
- Deep Learning operations are done outside of P
  - Graph based
  - Nodes are operations
  - Edges are multi-dimensional arrays called tensors

neon™ Framework

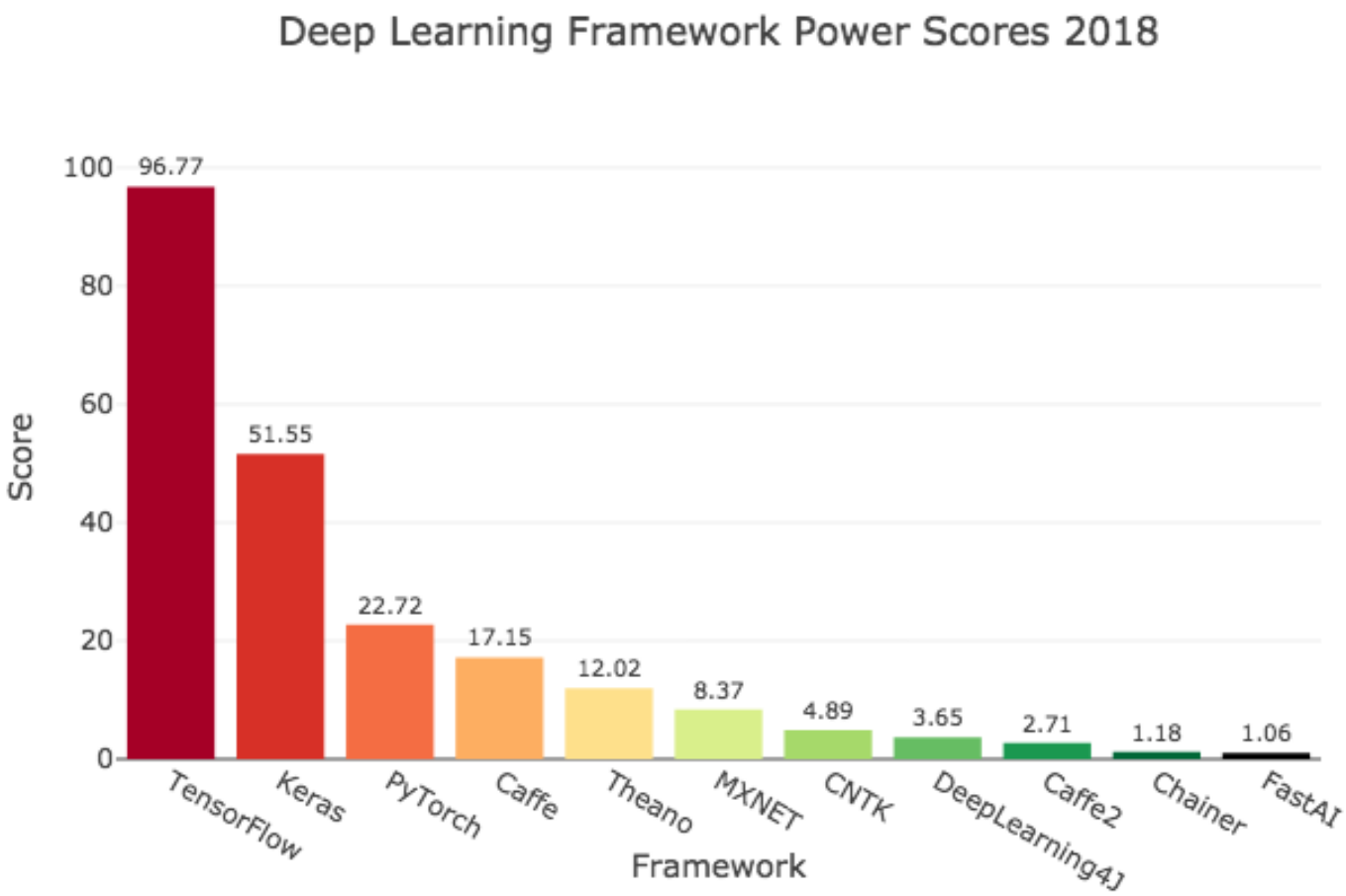
neon™ is a deep learning solution optimized for Intel® architecture.

- Nervana™ Systems, founded in 2014, open-sourced neon™ in 2015.
- Nervana Systems joined Intel in August 2016.
- Posted top benchmarks on both GPU and CPU architectures.
- Used assembly level optimizations to produce faster speeds.

Keras

- Keras is high-level neural networks API, written in Python
- Built on top of either Theano, CNTK or TensorFlow
- Most powerful & easy to use for developing and evaluating deep learning models
- Allows for easy and fast Prototyping (through user friendliness, modularity, and extensibility)
- Support both convolutional networks and recurrent networks, as well as combinations of the two
- Runs seamlessly on CPU and GPU

Power scores



https://www.kdnuggets.com/2018/09/deep-learning-framework-power-scores-2018.html

Which framework

	Languages	Tutorials and training materials	CNN modeling capability	RNN modeling capability	Architecture: easy-to-use and modular front end	Speed	Multiple GPU support	Keras compatible
Theano	Python, C++	++	++	++	+	++	+	+
Tensor-Flow	Python	+++	+++	++	+++	++	++	+
Torch	Lua, Python (new)	+	+++	++	++	+++	++	
Caffe	C++	+	++		+	+	+	
MXNet	R, Python, Julia, Scala	++	++	+	++	++	+++	
Neon	Python	+	++	+	+	++	+	
CNTK	C++	+	+	+++	+	++	+	

https://www.kdnuggets.com/2017/03/getting-started-deep-learning.html

End to End Computing for AI

Datacenter

Many-to-many hyperscale,
for stream and massive batch data processing

Ethernet
& Wireless

gateway

1-to-many,
majority streaming data from devices

Wireless & non-IP wired,
secure, high throughput, real-time

Edge

End to End Computing for AI

There are various hardware requirements for different AI tasks.

- AI tasks can include data collection and fusion, training, and inference.
- The number of operations for training can be on the order of exaFLOPS, making this task more suited for datacenters.
- Inference takes fewer operations than training and can be done on both edge devices and at datacenters.
- Certain applications can have constraints on the processor size and power. For example, wearable devices and drones.

End to End Computing for AI

Datacenter

Datacenters are used to store and process data for applications,
from websites to Internet of Things (IoT) systems.

- Low latency, high bandwidth – needed to access high compute resources.
- Reliability, lack of downtime, high performance.
- AI is the fastest-growing datacenter workload.
- A ~12X growth in demand by 2020 is expected.
- Training is typically done in a datacenter,
  allowing high processor power and physical size.

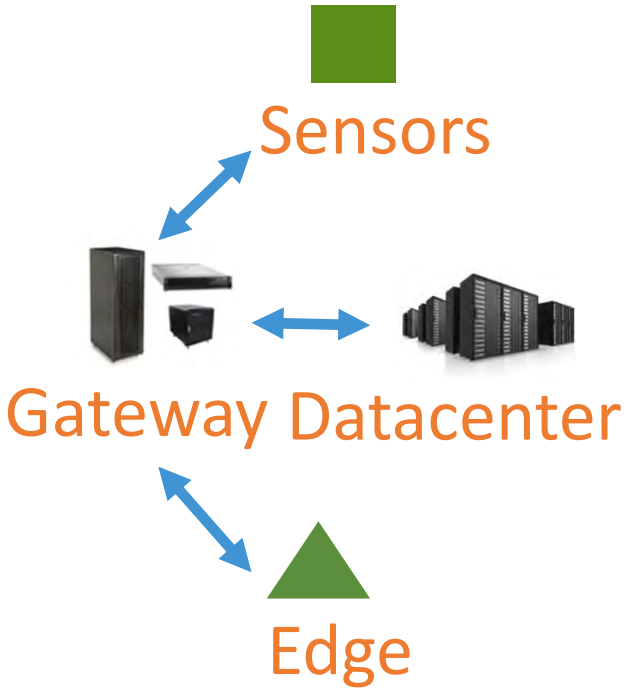
Datacenter

End to End Computing for AI

Gateway

Gateway computers route information from edge devices into and out of datacenters.

- High bandwidth – able to handle input from many devices and route correctly.
- Lightweight protocols – can't require extensive CPU usage, keeping gateway computer fast.
- Secure protocols – gateway computers are often a security point of failure.



End to End Computing for AI

Edge

Edge computing refers to computing happening as close as possible to where the computation is required.

- Sensors read information and compute a result directly on an Internet of Things (IoT) device, without sending information to data center.
- Reduces communication between sensors and datacenter.
- Uses resources that are not continuously connected to a network.
- Edge computing often used for inference rather than model training.

End to End Computing for AI

Example: Automated Driving

Autonomous vehicles produce ~4 terabytes of data per day.

One car, driving for one hour, requires ~5 exaFLOPS of computational power in order to safely keep it on the road.

DARPA Self-Driving
Car Challenge Won in 2005

End to End Computing for AI

Automated Driving

Vehicle requires:

- Human-Machine Interface (HMI) – to build trust between driver and vehicle and provide advanced virtualization and graphics capabilities
- Scalable, powerful in-vehicle computing
- Sensor processing
- Environment modeling
- Driving functions

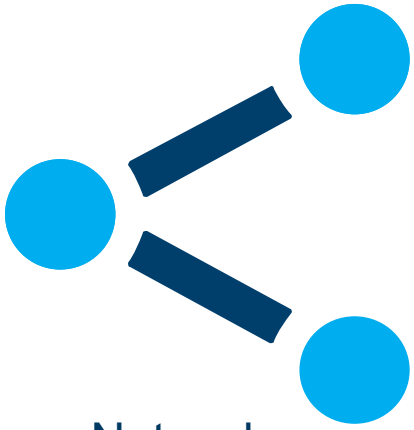
Car

End to End Computing for AI

Automated Driving

Network requires:

- Vehicle-to-vehicle (V2V) and Vehicle-to-everything (V2X) communication
- Next-generation network connectivity
- Over-the-air-updates
- High-definition maps

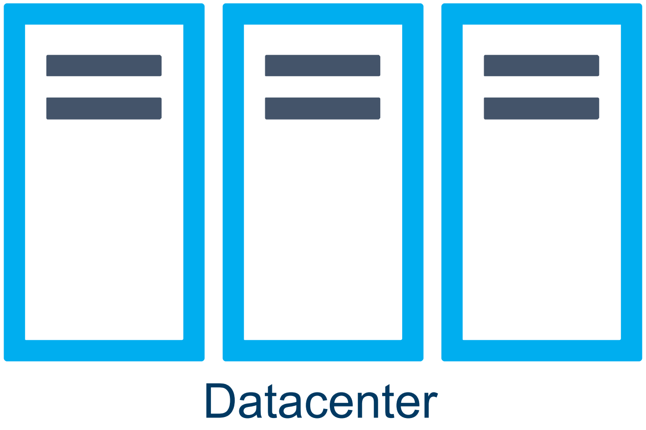


End to End Computing for AI

Automated Driving

Datacenter requires:

- High-performance data center and cloud
- AI to fleet management to data mining
- Model training
- Greater than real time inference



AI Hardware: FPGA

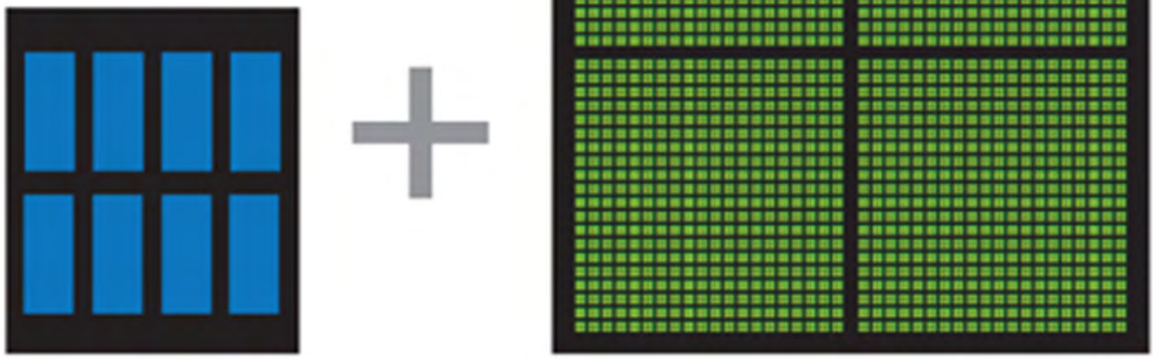
FPGA: Overview

Field Programmable Gate Arrays (FPGAs) are hardware that can be reconfigured – programmed in the field.

- FPGAs can become any digital circuit as long as the unit has enough logic blocks to implement that circuit.
- Enables the creation of custom hardware for individual solutions in an optimal way that other devices cannot efficiently support.
- High-throughput, low-latency processing of complex algorithms, such as neural networks.
- Flexible fabric enables direct connection of various inputs, such as cameras, without needing an intermediary.

http://www.theneuromorphic.com/

AI Hardware: GPU



CPU

DOZENS OF CORES

GPU

THOUSANDS OF CORES

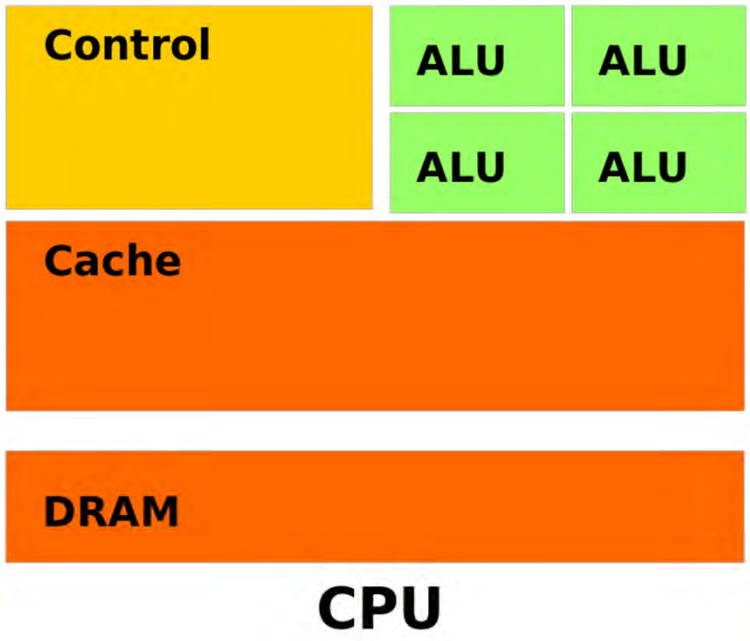
AI Hardware: GPU

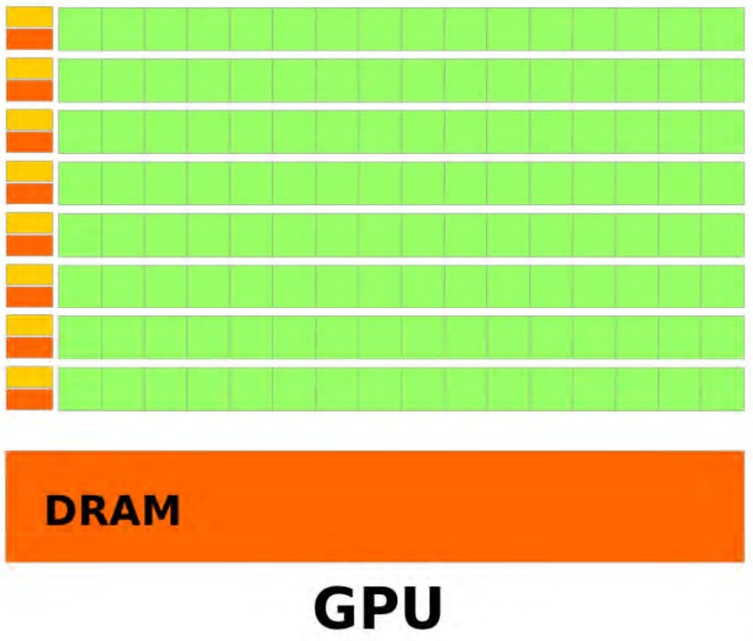
Originally designed to process graphics, GPUs have become a popular DL workhorse.

- Feature thousands of small, simple cores specialized for numeric, parallel computations.
- Many transistors dedicated to computation.
- GPUs excel at repeated similar instructions in parallel.
- Optimized for parallel data throughput computation.
- Major neural net breakthroughs since 2012 have been powered by GPU computations – performance has since increased >5x.
- Once the data is in the GPU memory the bottlenecks are small.
- NVIDIA is highly popular in discrete GPUs

AI Hardware: GPU

CPUs vs GPUs





AI Hardware: GPU

CPUs vs GPUs

While GPUs are specialized processors, CPUs are still the main computation engines on most computers.

- CPUs have dozens of cores compared to GPUs that have thousands of less powerful cores.
- CPUs have fewer arithmetic logic units (ALUs) and a lower compute density than GPUs
- CPUs are lower latency and have larger cache memory compared to GPUs

AI Hardware: GPU

CPUs vs GPUs

While GPUs are specialized processors, CPUs are still the main computation engines on most computers.

- GPUs are designed for parallel tasks and perform well when a single instruction is to be performed over a large amount of data.
- GPUs have additional overhead when copying data from main memory is required so CPUs can be better when a large number of memory swaps are needed.
- GPUs are not good for tasks that cannot be parallelized or when heavy processing on fewer data streams is needed. CPUs excel at serial tasks.
- CPUs are easy to program – popular programming languages compile to machine code, to be run on CPU by default.

AI Hardware: GPU

NVIDIA GPUs

NVIDIA‘s main business is in dedicated hardware for discrete graphics processors.

Several factors have made NVIDIA highly popular in this space.

- CUDA* framework which lets developers write code in C++, Python*, and other popular languages that run optimized operations on the GPU.
- Early incorporation of GPUs with cloud services, such as Amazon Web Services*.
- For several years, NVIDIA facilitated ecosystem adoption by optimizing their libraries and abstracting the complexities of the GPU through SDKs, tools, and libraries.

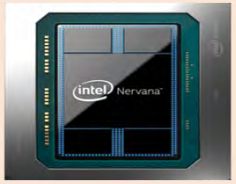
AI Custom Hardware

AI runs on both general purpose processors and on specialized hardware.

Specialized Hardware

Google TPU*

Apple Neural Engine*



Intel® Nervana™ NNP

Intel® Movidius™

AI Custom Hardware

Google Tensor Processing Unit* (TPU)

Google's TPU* is the first major example of a chip designed for AI.

- Google's first-gen TPU (2015) was designed specifically for fast inference.
- Unlike a GPU, no capabilities for graphics tasks, such as rasterization or texture mapping.
- Second-gen (2017) increased the precision available for computations, making this version usable for training as well.

AI Custom Hardware

Apple Neural Engine*

Apple Neural Engine* system is on a chip designed for fast inference.

- Apple Neural Engine shipped on late 2017 iPhones.
- Separate from main CPU and GPU on iPhone.
- Specifically designed for fast neural net inference, capable of 600 billion operations per second.
- Highlighted importance of fast neural net inference to Apple's ability to provide its desired user experience.

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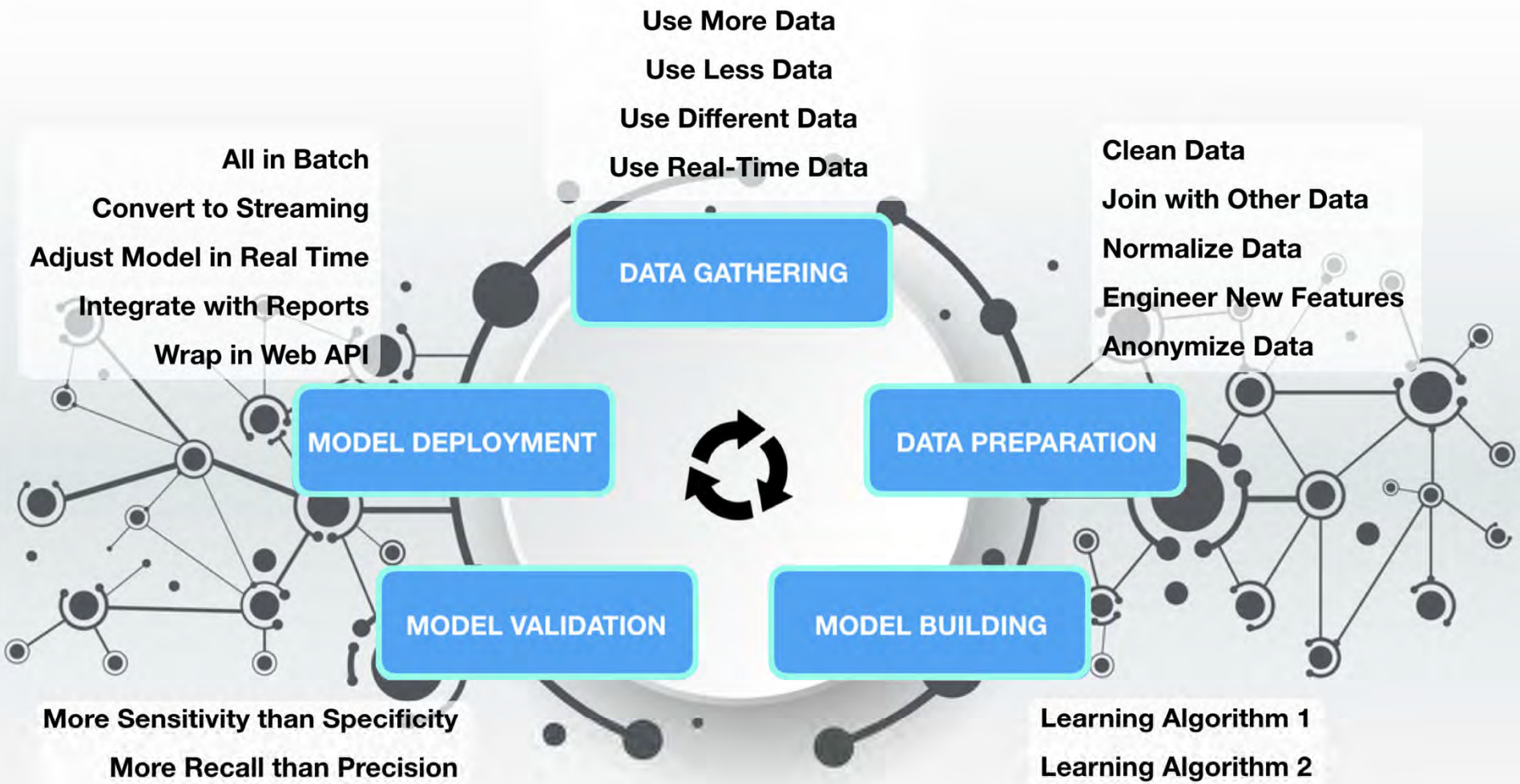
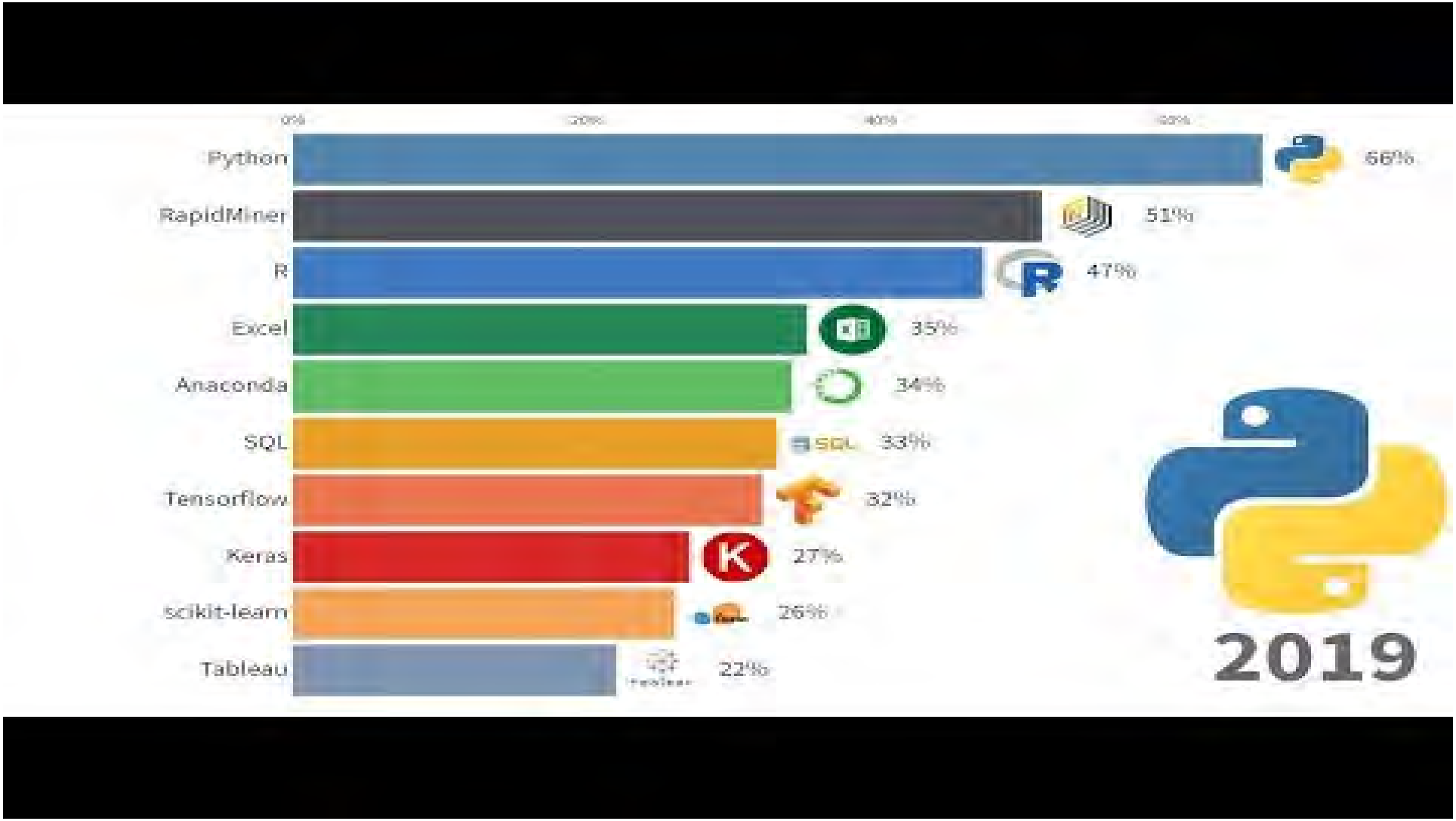
- Highlighted importance of fast neural net inference to Apple's ability to provide its desired user experience.

AI/ML Workflow



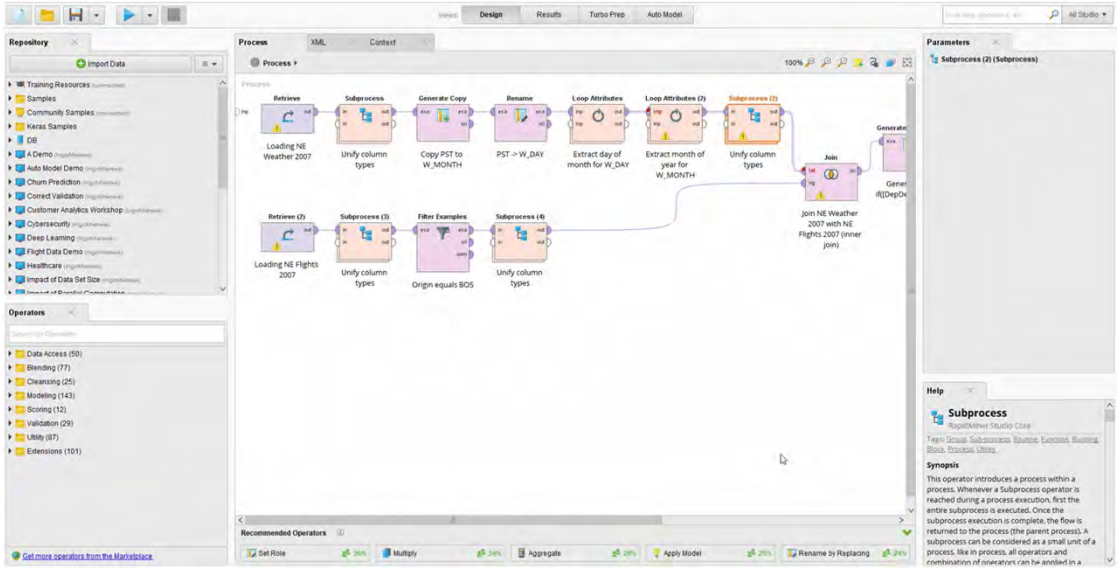
https://towardsdatascience.com/gui-fying-the-machine-learning-workflow-towards-rapid-discovery-of-viable-pipelines-cab2552c909f

What are the popular tools?

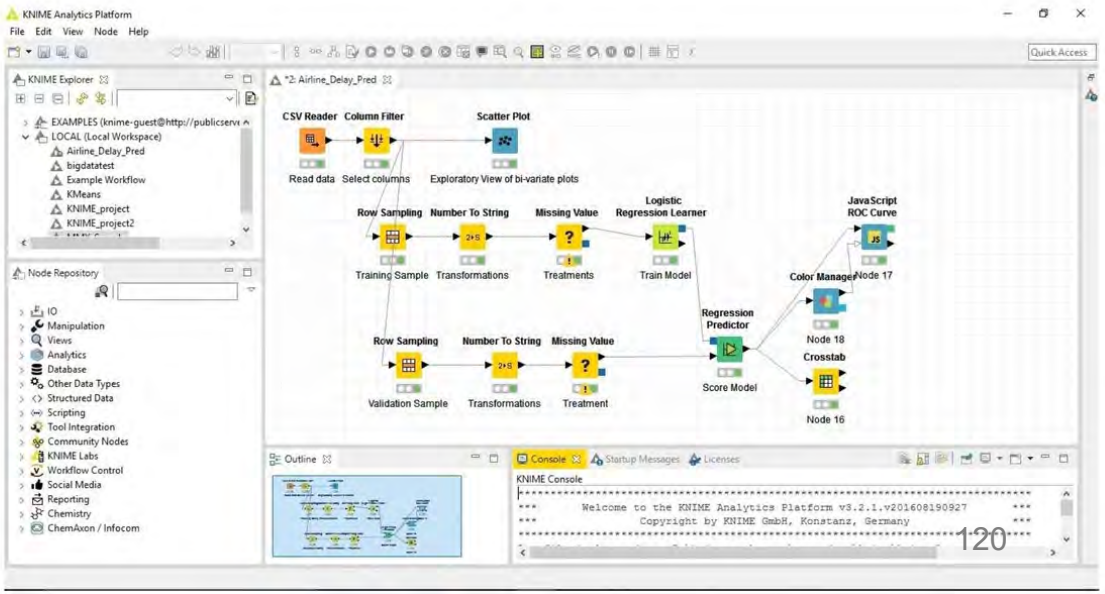


https://youtu.be/pKPaHH7hnv8

Graphical Tools (ML/DS)

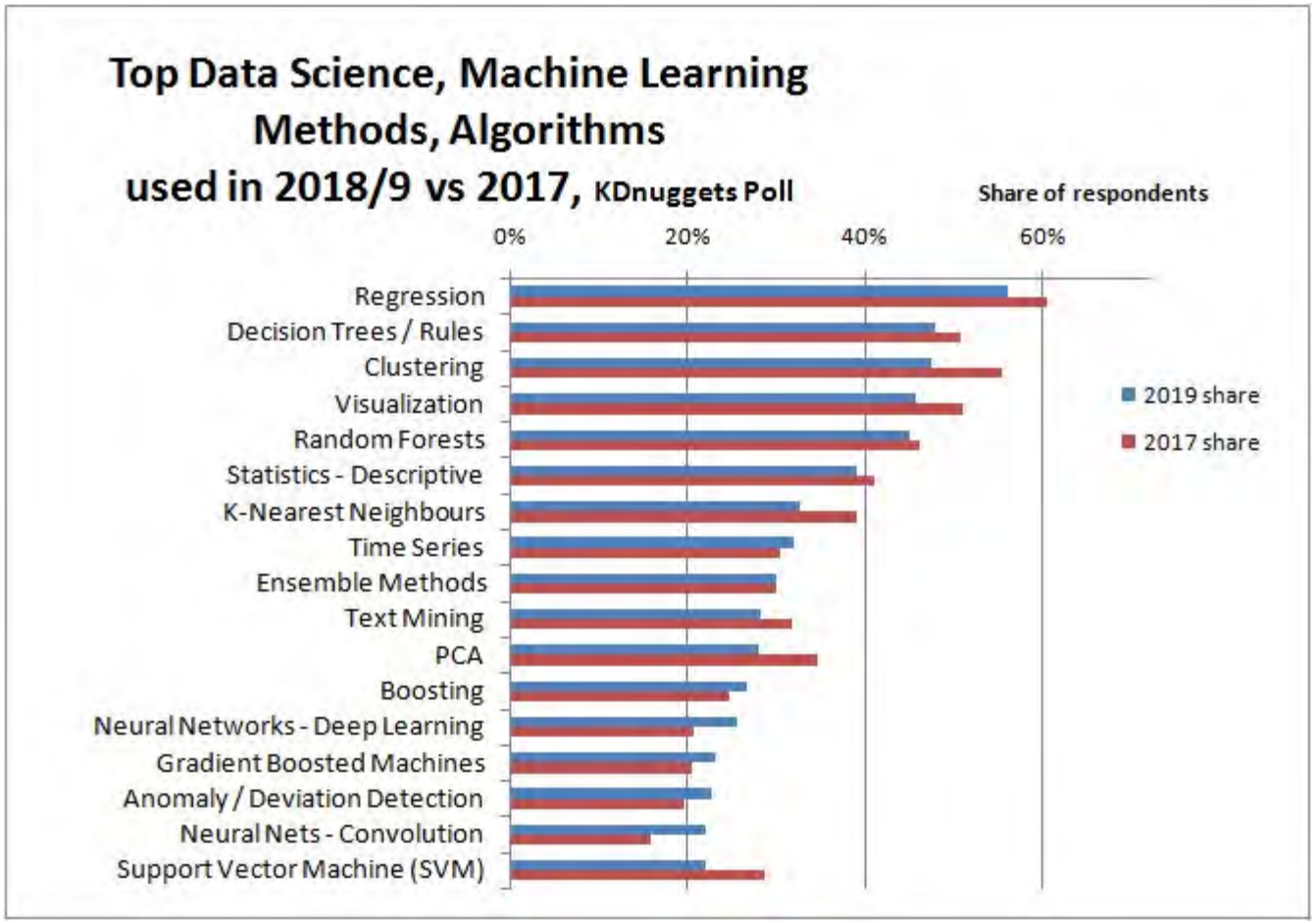


RapidMiner



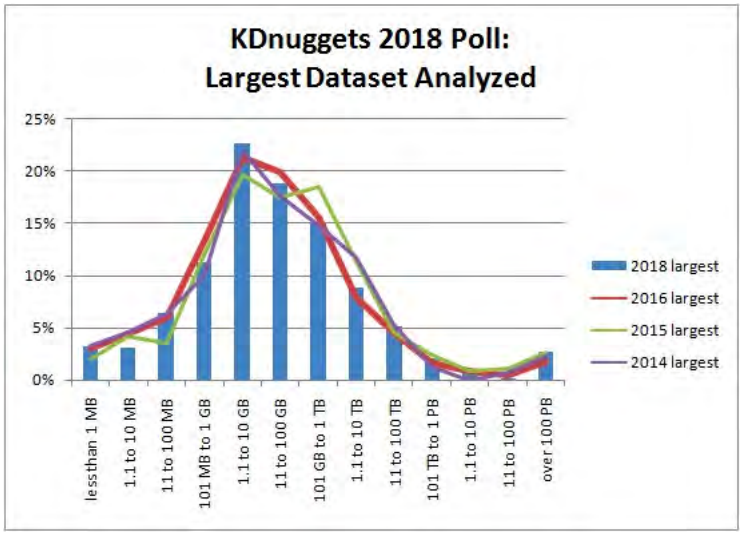
KNIME

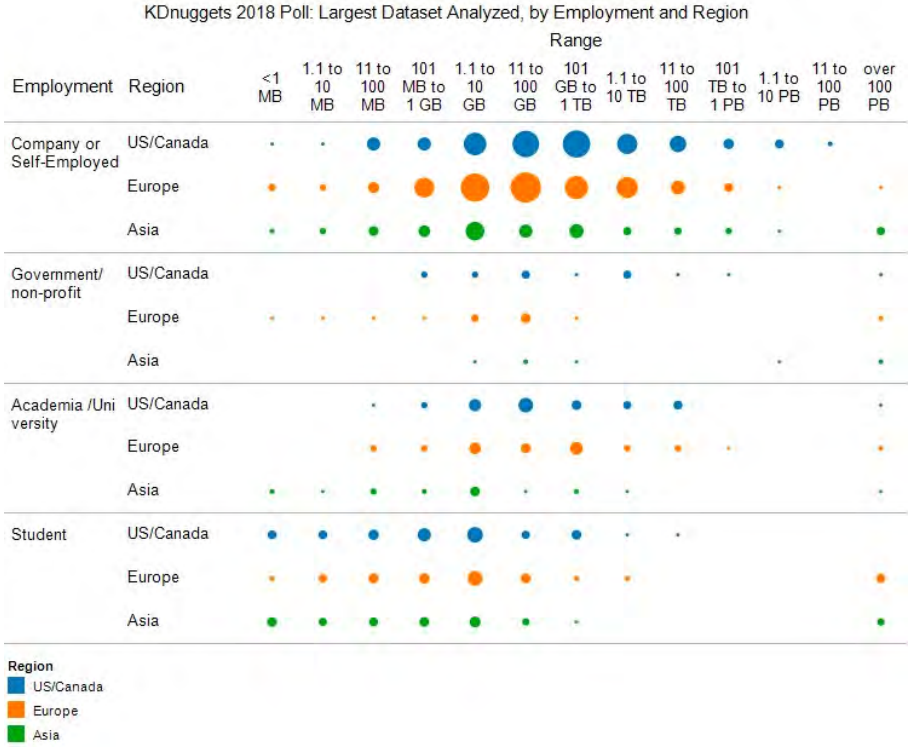
Top Methods/algorithms

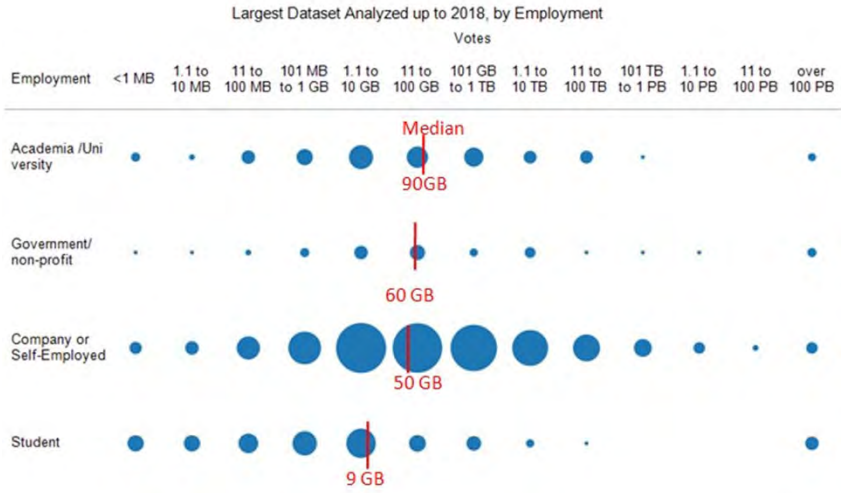


https://www.kdnuggets.com/2019/04/top-data-science-machine-learning-methods-2018-2019.html

Datasets size







https://www.kdnuggets.com/2018/10/poll-results-largest-dataset-analyzed.html

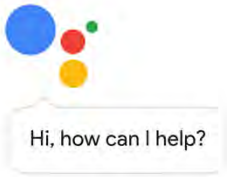
REPUBLIC POLYTECHNIC

DISCOVER. TRANSFORM. ACHIEVE.

AI Services

AI Services

- Google Search
- Google Assistant (hands on)
- Google Photo (image recognition)
- Speech Recognition



- Google's AI Services for Companies
  - https://experiments.withgoogle.com/collection/ai

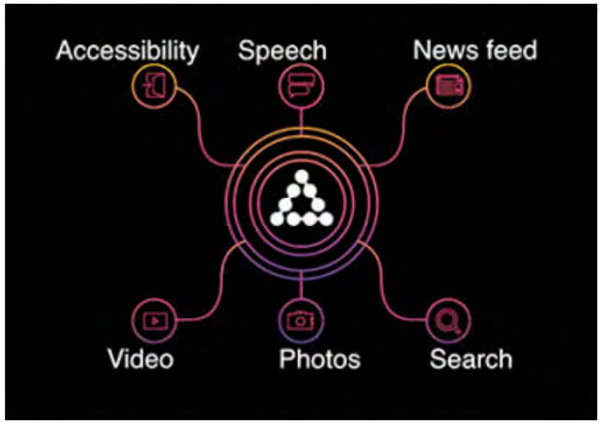
- Google's cloud-based AI Tools
  - https://ai.google

- Google's AI Experiments:
  - https://experiments.withgoogle.com/ai

- Do-it-Yourself AI:
  - https://aiyprojects.withgoogle.com/voice/

AI Services

- Facebook Photo search
- FBLearner Flow (https://code.fb.com/ml-applications/introducing-fblearner-flow-facebook-s-ai-backbone/)
- Text Analytics (Deep Text)
- Pattern Recognition to Prevent Suicides
- Improving 360 Degree Photos
- Computer Vision
- Facebook Personal Assistant M (experiment)
- Facebook Messenger Platform Chatbot
- Facebook's AI research Activities
  - https://research.fb.com/category/facebook-ai-research/



Facebook will use AI to help correct skewed 360-degree photos

The company has a technique for dealing with big file sizes, too.

TECHNOLOGY NEWS NOVEMBER 28, 2017 / 12:05 AM / A YEAR AGO

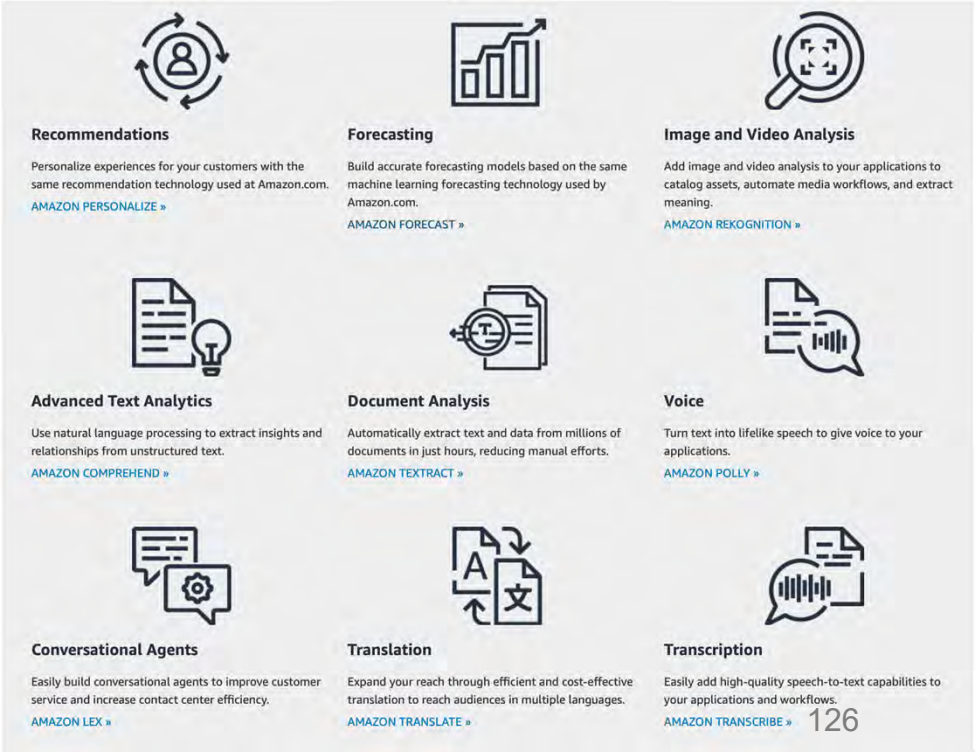
Facebook to expand artificial intelligence to help prevent suicide

David Ingram 3 MIN READ

AI Services

- Amazon Recommended Products
- Alexa Personal Assistant
- Cloud Storage

- Amazon's AI platform:
  - Amazon Lex
  - Amazon Polly
  - Amazon Recognition



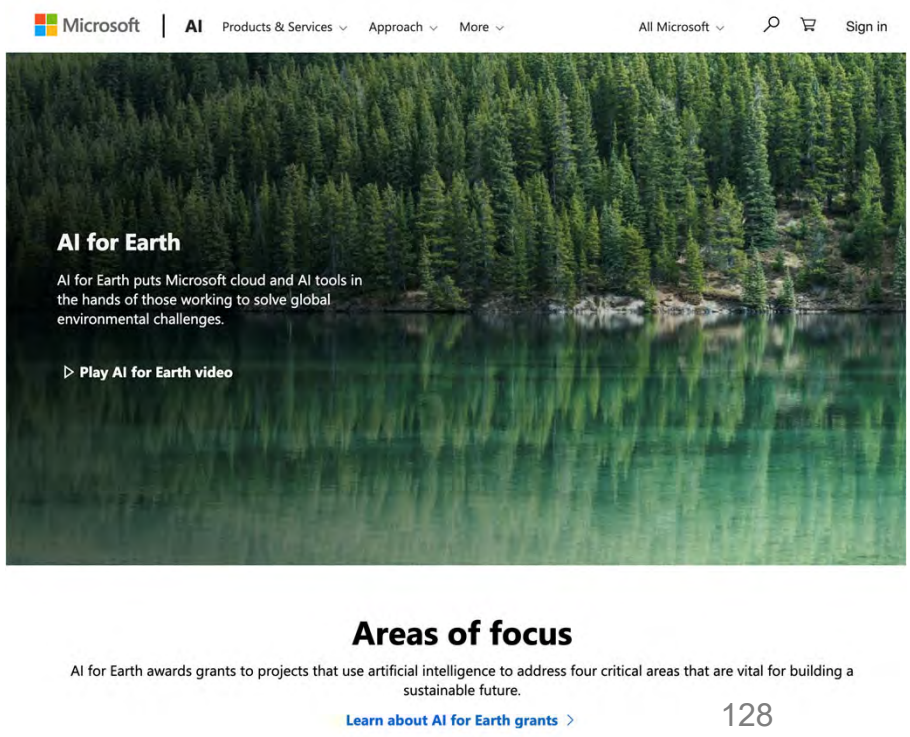
https://aws.amazon.com/machine-learning/

Amazon Rekognition

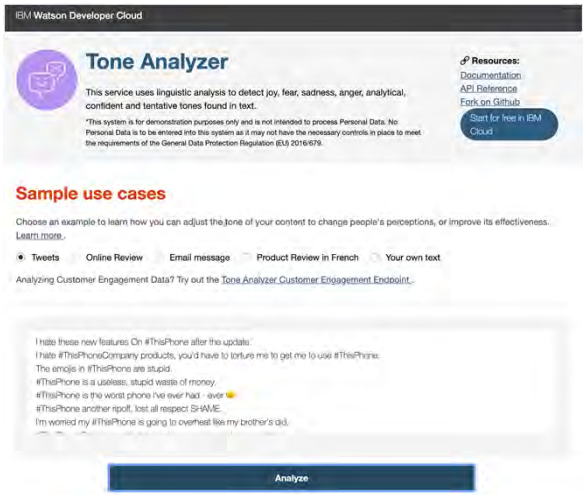
AI Services

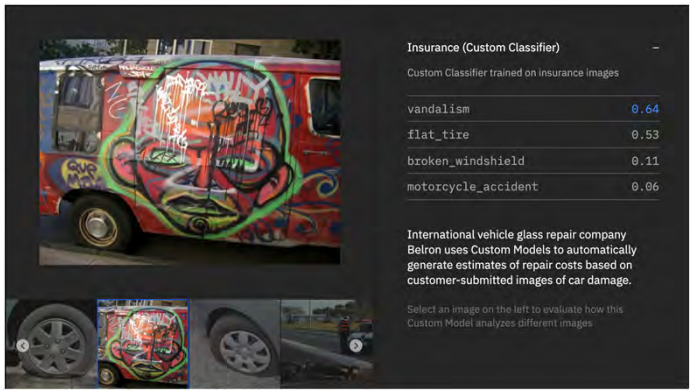
- Cortana - https://www.microsoft.com/en-us/windows/cortana
- Presentation Translator - https://translator.microsoft.com/help/presentation-translator
- HoloLens
- InnerEye - https://www.microsoft.com/en-us/research/project/medical-image-analysis/
- Azure Microsoft Cloud Service –
- AI for Earth - https://www.microsoft.com/en-us/ai/ai-for-earth
- AI Language Translator - https://www.microsoft.com/en-us/translator/ https://www.bing.com/translator (demo)

Microsoft



AI Services





- Cognos Analytice - https://www.ibm.com/sg-en/products/cognos-analytics
- Tone Analyzer - https://tone-analyzer-demo.ng.bluemix.net (demo)
- Discovery - https://discovery-news-demo.ng.bluemix.net
- Visual Recognition - https://www.ibm.com/watson/services/visual-recognition/demo/#demo
- Text to Speech - https://text-to-speech-demo.ng.bluemix.net/ (audio streaming does not work on mobile browser)

AI Services

- Speech Recognition on Siri
- QuickType
- A11 Bionic Chip – Core ML
- Apple Music
- Apple HomePod
- Apple Photos

Apple acquires AI tech that seeks to understand your photos

Regaind can tell good pics from bad ones, and interpret what's going on.

Apple has new self-driving car hardware covered with iPod-style white plastic

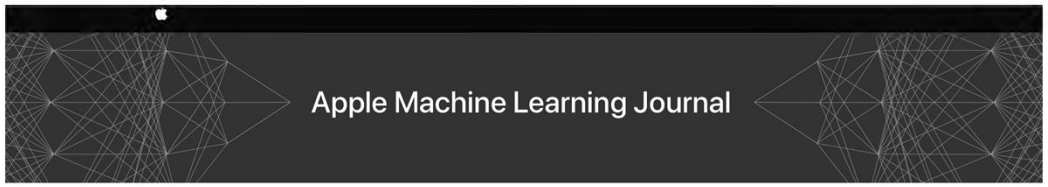
Kif Leswing, Business Insider US

October 18, 2017

71,188 views | Dec 26, 2016, 07:05am

Apple Publishes Its First Artificial Intelligence Paper

Aaron Tilley Forbes Staff



Optimizing Siri on HomePod in Far-Field Settings

Vol. 1, Issue 12 · December 2018

by Audio Software Engineering and Siri Speech Team

AI Services

Robots Run the Warehouses (link)

Alibaba Group

Innovation

Alibaba lets AI, robots and drones do the heavy lifting on Singles' Day

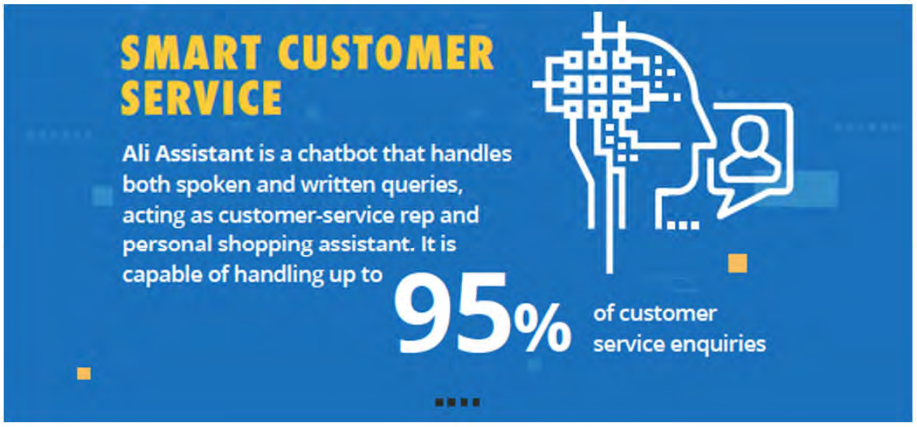
This year's November 11 shopping ritual will engage a recommendation algorithm, robots, and chatbots capable of understanding human emotion

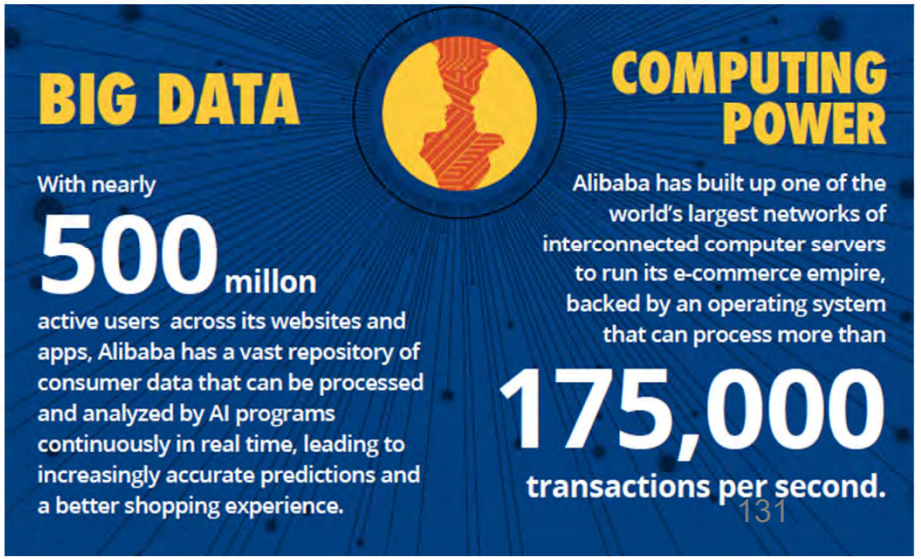
Topic | Singles' Day (11.11)

Intelligent Machines

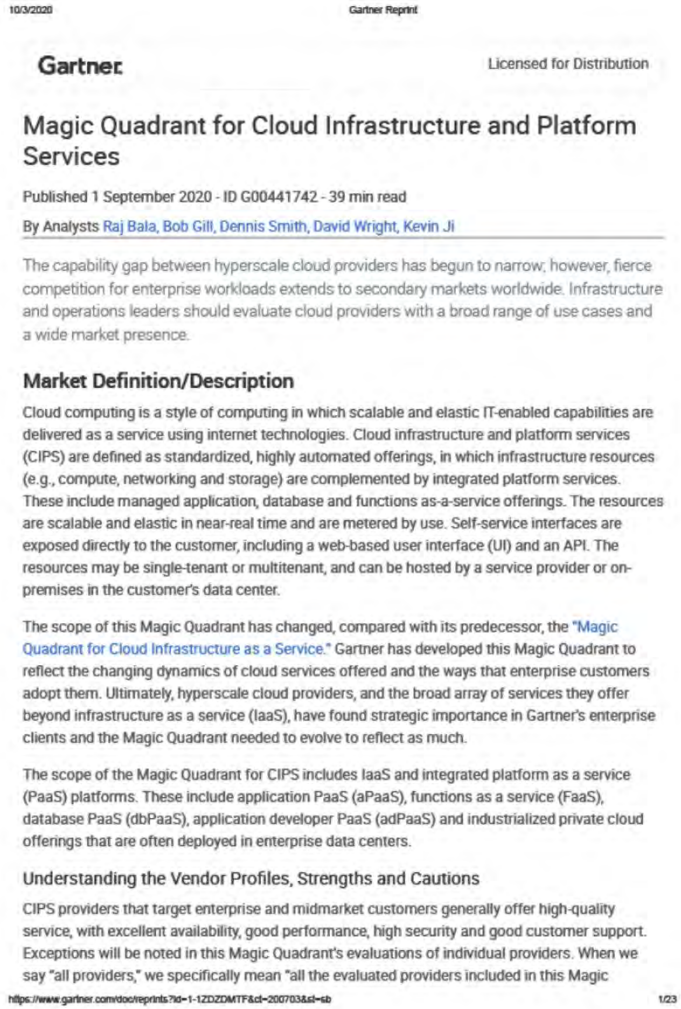
Alibaba's AI Fashion Consultant Helps Achieve Record-Setting Sales

AI will blur the line between online and offline retail.





Magic Quadrant for Cloud Infrastructure and Platform Services



10/3/2020 Gartner Reprint

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Magic Quadrant for Cloud Infrastructure and Platform Services

Published 1 September 2020 - ID G00441742 - 39 min read

By Analysts Raj Bala, Bob Gill, Dennis Smith, David Wright, Kevin Ji

The capability gap between hyperscale cloud providers has begun to narrow; however, fierce competition for enterprise workloads extends to secondary markets worldwide. Infrastructure and operations leaders should evaluate cloud providers with a broad range of use cases and a wide market presence.

Market Definition/Description

Cloud computing is a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service using internet technologies. Cloud infrastructure and platform services (CIPS) are defined as standardized, highly automated offerings, in which infrastructure resources (e.g., compute, networking and storage) are complemented by integrated platform services. These include managed application, database and functions as-a-service offerings. The resources are scalable and elastic in near-real time and are metered by use. Self-service interfaces are exposed directly to the customer, including a web-based user interface (UI) and an API. The resources may be single-tenant or multitenant, and can be hosted by a service provider or on-premises in the customer's data center.

The scope of this Magic Quadrant has changed, compared with its predecessor, the "Magic Quadrant for Cloud Infrastructure as a Service." Gartner has developed this Magic Quadrant to reflect the changing dynamics of cloud services offered and the ways that enterprise customers adopt them. Ultimately, hyperscale cloud providers, and the broad array of services they offer beyond infrastructure as a service (IaaS), have found strategic importance in Gartner's enterprise clients and the Magic Quadrant needed to evolve to reflect as much.

The scope of the Magic Quadrant for CIPS includes IaaS and integrated platform as a service (PaaS) platforms. These include application PaaS (aPaaS), functions as a service (FaaS), database PaaS (dbPaaS), application developer PaaS (adPaaS) and industrialized private cloud offerings that are often deployed in enterprise data centers.

Understanding the Vendor Profiles, Strengths and Cautions

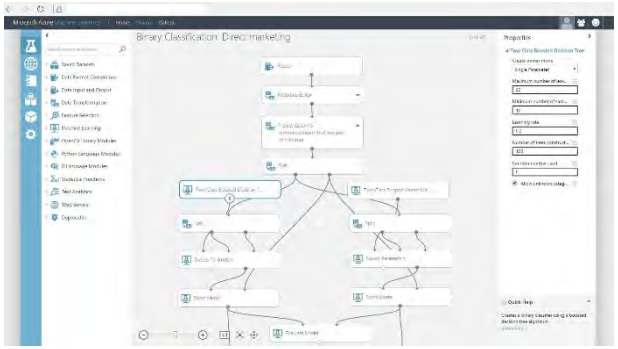
CIPS providers that target enterprise and midmarket customers generally offer high-quality service, with excellent availability, good performance, high security and good customer support. Exceptions will be noted in this Magic Quadrant's evaluations of individual providers. When we say "all providers," we specifically mean "all the evaluated providers included in this Magic

https://www.gartner.com/doc/reprints?id=1-1ZDZDMTF&ct=200703&st=sb 1/23

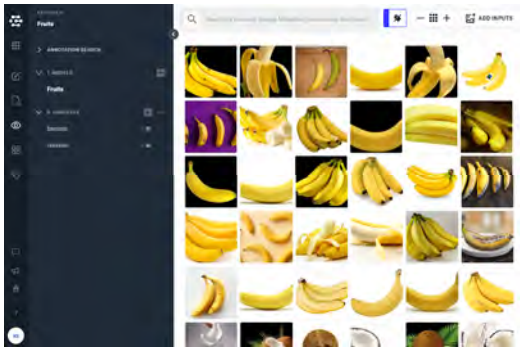
https://cloud.google.com/gartner-cloud-infrastructure-as-a-service

Other AI services

Microsoft Azure Machine Learning Studio (Classic)



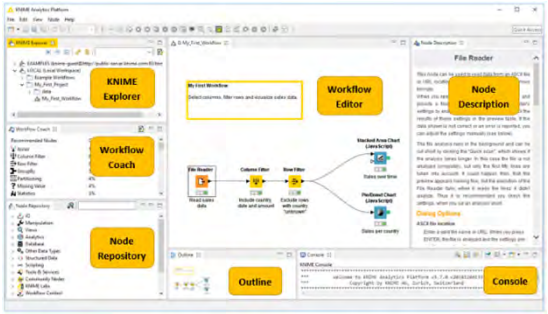
Clarifai



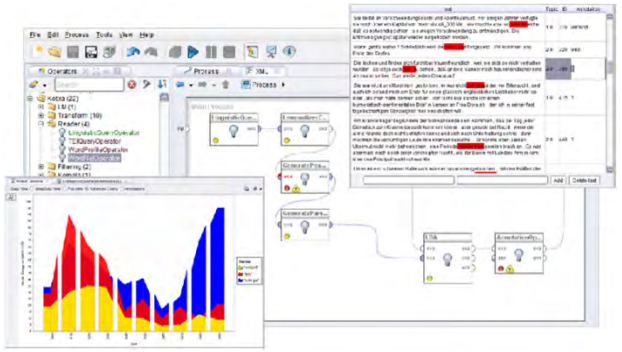
Peltarion

bigml

KNIME



Rapidminer

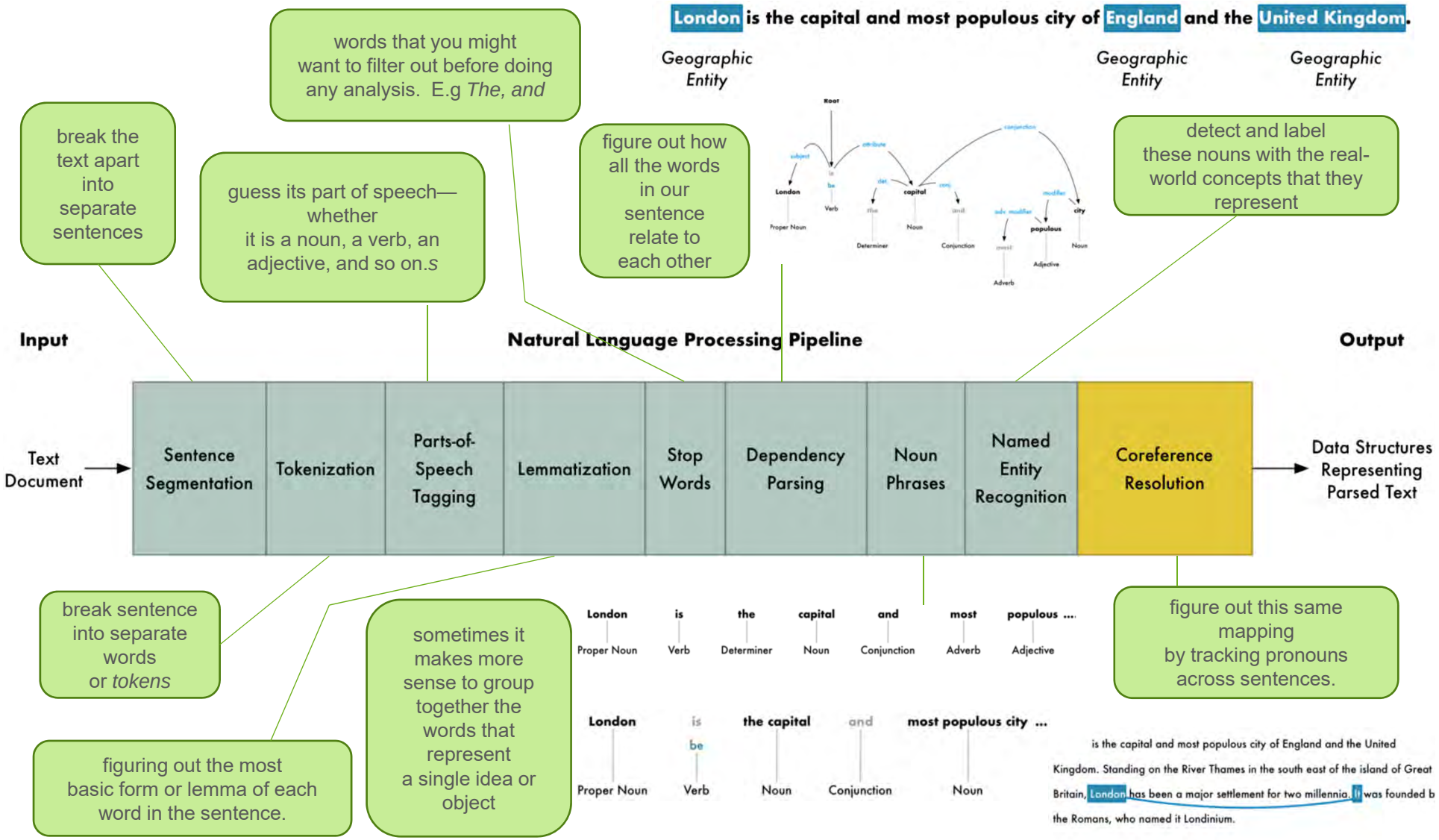


Function specific AI services

Sales	Outreach.io
Virtual Human	https://www.quantumcapture.com/ctrl-human
HR Services	https://leena.ai/HR-FAQ
Scheduling	https://x.ai/how-it-works/
Enterprise support functions	https://www.soapbox.ai/
Sales Bots	https://octaneai.com/
AI-Powered Transcription	http://capio.ai/index.html
Hiring	https://hiringsolved.com/product
Programming	https://www.codota.com/enterprise https://kite.com/

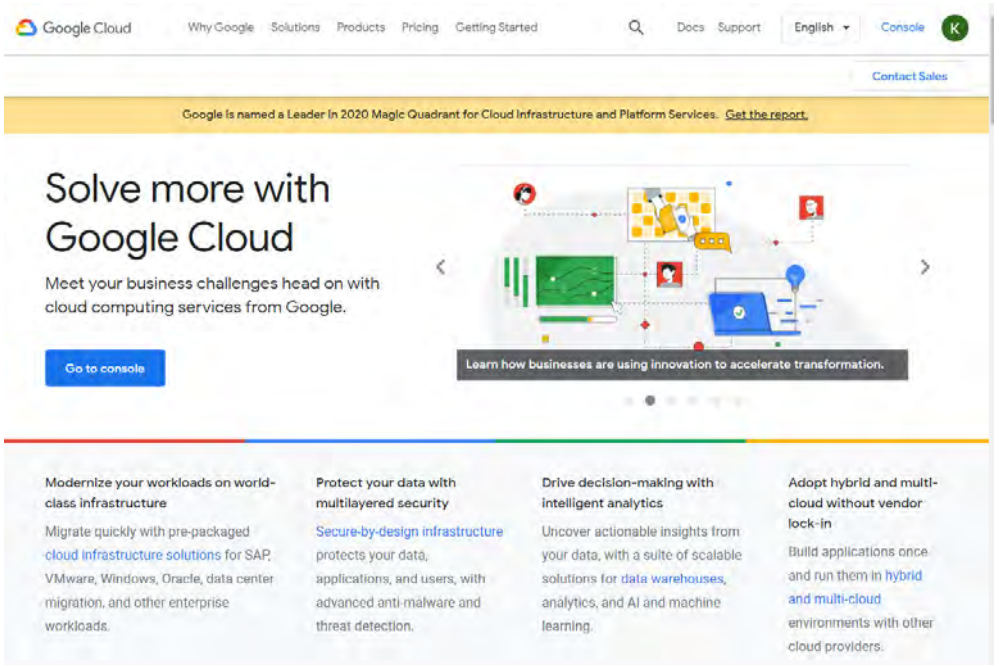
Hands On

Hands-on NLP


London is the capital and most populous city of England and the United Kingdom.
Geographic Entity
Geographic Entity
Geographic Entity
words that you might want to filter out before doing any analysis. E.g The, and
break the text apart into separate sentences
guess its part of speech— whether it is a noun, a verb, an adjective, and so on.s
figure out how all the words in our sentence relate to each other
detect and label these nouns with the real-world concepts that they represent
Input
Natural Language Processing Pipeline
Output
Text Document
Sentence Segmentation
Tokenization
Parts-of-Speech Tagging
Lemmatization
Stop Words
Dependency Parsing
Noun Phrases
Named Entity Recognition
Coreference Resolution
Data Structures Representing Parsed Text
break sentence into separate words or tokens
figuring out the most basic form or lemma of each word in the sentence.
sometimes it makes more sense to group together the words that represent a single idea or object
London is the capital and most populous ...
Proper Noun Verb Determiner Noun Conjunction Adverb Adjective
London is the capital and most populous city ...
Proper Noun Verb Noun Conjunction Noun
figure out this same mapping by tracking pronouns across sentences.
is the capital and most populous city of England and the United Kingdom. Standing on the River Thames in the south east of the island of Great Britain, London has been a major settlement for two millennia. It was founded b the Romans, who named it Londinium.

Hands-on NLP

- Use Google Cloud Platform, we will:
  - Classify Text
  - Named Entity Recognition
  - Sentiment Analysis
  - Syntax Analysis
- Activity 1 & 2



Step 1:
Watch and listen to the instructor's demonstration

20 mins

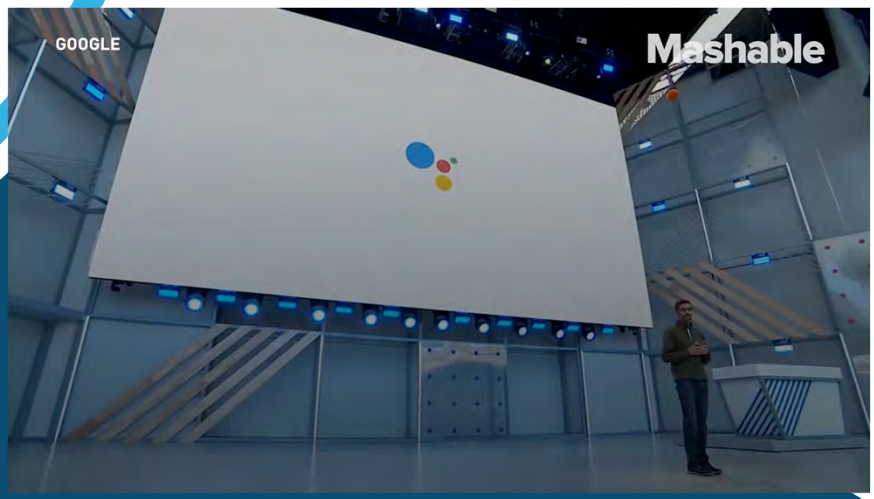
Step 2:
- Do on your own

40 mins

Individual Activity

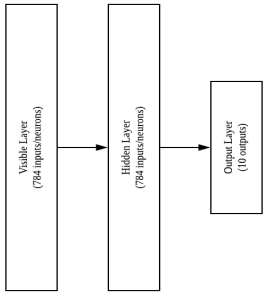
15 Mins Break

bit.ly/google_duplex2019

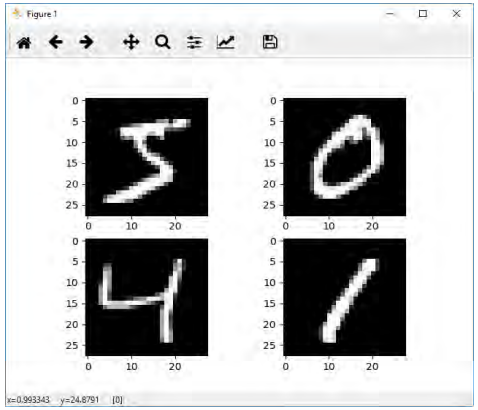


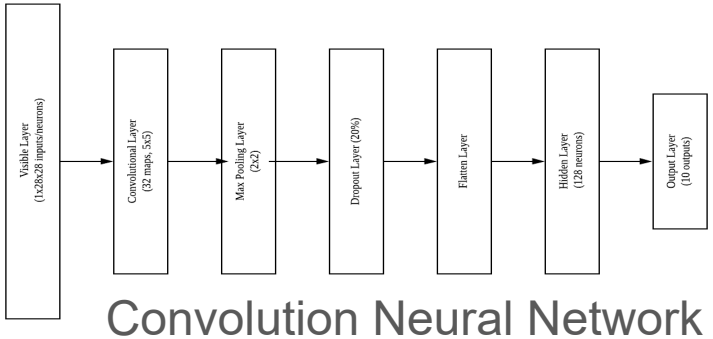
Hands on – Object Recognition

- Recognition handwritten digits (MNIST dataset)
- Using a Multilayer Perceptrons Neural Network
- Using a simple Convolution Neural Network



Multilayer Perceptrons
Neural Network





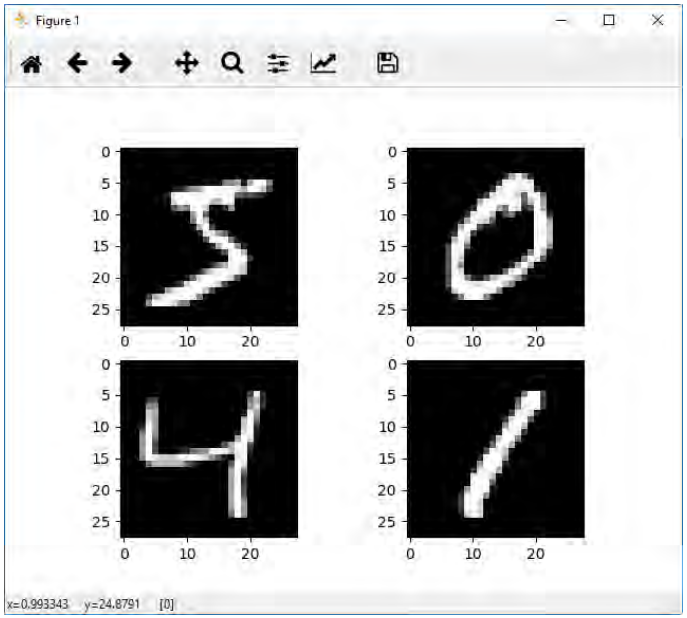
Convolution Neural Network

Keras

Hands on – Object Recognition

- Workflow

1. Load Data.
2. Define Model.
3. Compile Model.
4. Fit/Train Model.
5. Evaluate Model.
6. Predict with new data.



Keras

Step 1:
Watch and listen to the instructor's demonstration

20 mins

Step 2:
- Do on your own

40 mins

Individual Activity

Many Examples of how AI is applied

Applications

Navigation

Google & Waze find the fastest route, by processing traffic data.

Ride sharing

Uber & Lyft predict real-time demand using AI techniques, machine learning, deep learning.

Audience

Facebook & Twitter use AI to decide what content to present in their feeds to different audiences.

Content

Image recognition and sentiment analysis to ensure that content of the appropriate "mood" is being served.

Natural language

We carry around powerful natural language processing algorithms in our phones/computers.

Object detection

Cameras like Amazon DeepLens* or Google Clips* use object detection to determine when to take a photo.

Deep Learning "proven" to work for image classification.

Models outperform humans on image classification.

Object detection models beat previous benchmarks.

2012 2015 2016

Application Area: Abandoned Baggage Detection

- We can automatically detect when baggage has been left unattended, potentially saving lives.
- This system relies on the breakthroughs we discussed:
  - Cutting edge object detection.
  - Fast hardware on which to train the model (Intel® Xeon® processors in this case).

Abandoned baggage

intel

Finance

- Better Customer Service
- More Reliable Investment Services with Robot Advisor
- Greater Efficiency with Less Paperwork
- Improved Financial Security

JPMorgan Chase Uses COIN Machine Learning Program To Eliminate 360K Lawyer Hours A Year

TREND 1

Readying for banking's shift from mobile-first to AI-first

Artificial intelligence (AI) in banking is not new. Banks are already using AI in heavily-manual processes for accuracy, efficiency, speed and cost benefits. What is new, however, is the move of AI beyond process to interaction. The next stage of AI in banking will be toward simple and smarter interfaces: drawing on machine learning that adapts to data and interactions to improve areas like fraud detection, and tapping AI-enabled tools (like centralized platforms/assistants or messaging bots) to better converse with and offer services to customers in the front-office. Relying on AI for some internal and external interactions will help elevate the customer experience and move staff to more judgment-based and higher value added roles.

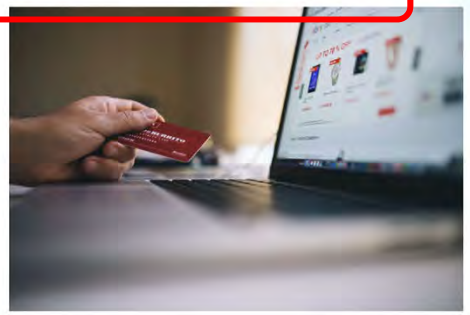
Fraud Detection

Traditionally **:** Fraud is on the rise, but fraud detection is a challenging problem to solve correctly.

- Historically, a predefined rule-set was used for fraud identification, but this approach misses much of the nuance that surrounds fraud
- 1/3 of falsely identified fraud events result in lost customers
- In the US, this loss is worth 13 times the cost of actual fraud

Now with AI **:** With ML techniques, banks can predict fraud based on a behavioral baseline to compare against.

- Uses historical shopping data and shopping habits of customers
- Compares new data to baseline to determine likelihood of fraud



Example: Sift Science

- Established a fraud data consortium developed from over 6000 websites to leverage large-scale real-time ML
- Autonomously learns new fraud patterns based on billions of user actions

Risk Management

Traditionally : New regulations force tighter control on financial institutions.

- New business model disruptions
- Increasing pressure on costs and returns

Now with AI : ML can help discern the credit worthiness of potential customers

- Tailor a financial portfolio to fit the goals of the user using ML algorithms.
- Financial institutions can develop early warning systems for automated reporting, portfolio management, and recommendations based on ML.

Example: ZestFinance

- Traditional underwriting systems make decisions using few data points.
- Those with a limited credit history are often denied credit, ultimately leading to loss of revenue for lenders.
- ZestFinance leverages thousands of data sources together with ML to more accurately score borrowers, even people with a small credit history.

Stock Trading

Traditionally : The speed and volume of information is daunting.

- The market is reactionary.
- It's difficult to remain competitive while relying on traditional trading methods.
- Fundamental analysis is unable to show the entire financial picture.

Now with AI : Companies use massive datasets together with DL methods for better forecasting.

- Data pulled from financial, political, and social media
- Analyst reports combined.

Example: Sentient Technologies, and Learning Evolutionary Algorithm Framework (LEAF*)

- Manages millions of data points to find trends and make successful stock trades.
- AI algorithms identify and combine successful trading patterns.
- Successful strategies are tested in the real world, evolving autonomously with LEAF.
- Sentient has received more funding than any other AI company.

Travel

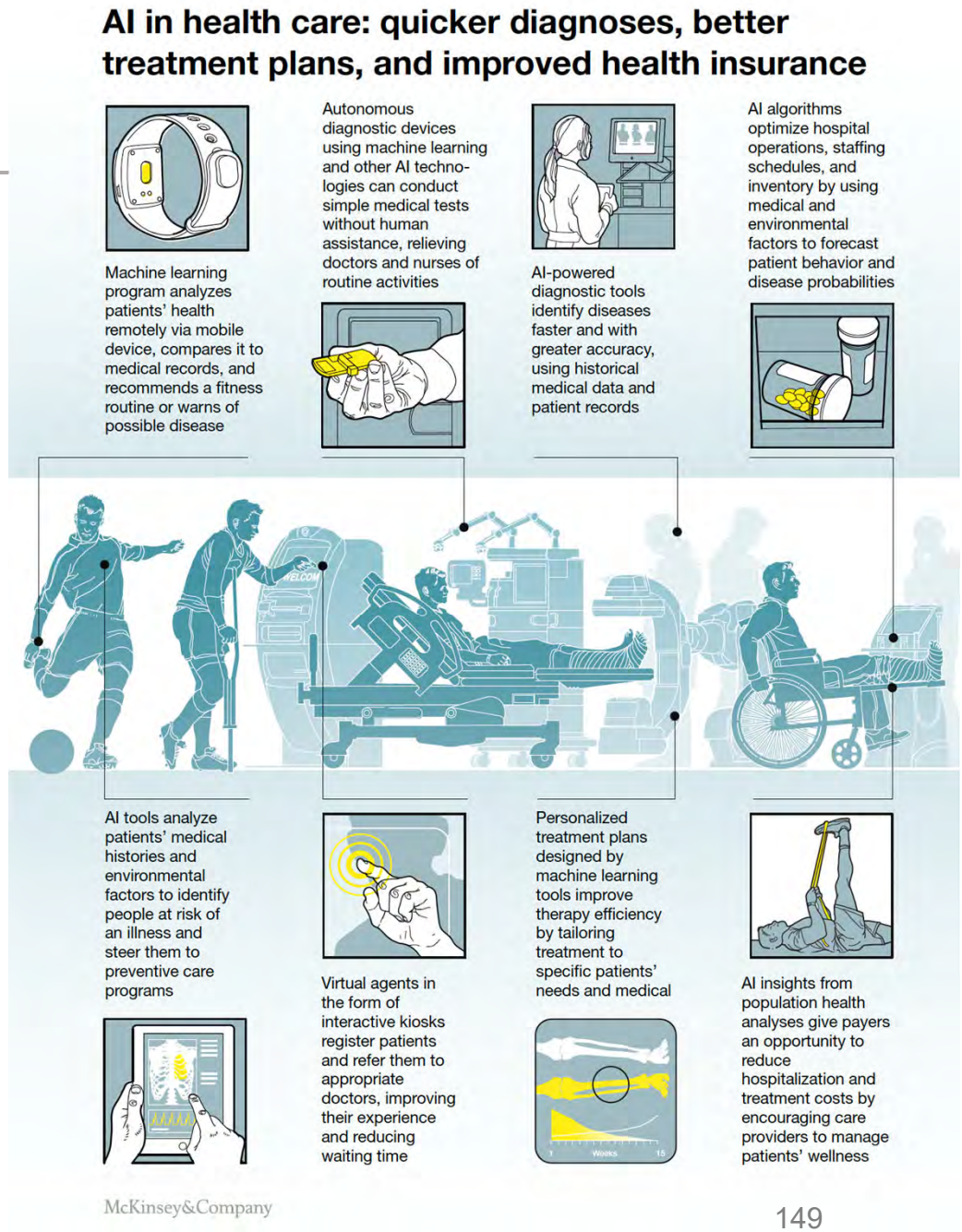
- Hotel Bookings by Voice Command
- AI Concierge Services
  - https://techcrunch.com/2018/06/19/amazon-launches-an-alexa-system-for-hotels/
- Travel Service Chatbots
- Check-in Through Facial Recognition
- Self-Driving Cars and Mobility as a Service
  - https://www.economist.com/international/2016/09/29/it-starts-with-a-single-app
- Other Robotic Tools

Healthcare

- IBM Watson, Google Deepmind
- At-home testing and personalized health care
- Wearables
- Robot-Assisted Surgery
- Virtual Nursing Assistant
- Administrative Workflow assistance

Healthcare

- Make quicker diagnoses, create better treatment plans and enable new approaches to insurance
- Identify public-health threats and the most at-risk patients
- help medical professionals diagnose disease and improve operations
- Insurers can devise new ways to encourage
- preventive care and incentivize providers
- Doctors will be able to tailor treatments—even drugs—to individual patients
- Virtual agents can serve as primary touchpoints for patients
- Several hurdles stand in the way, starting with data availability



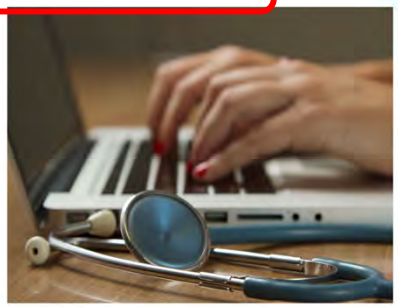
Healthcare – Medical Diagnosis

Traditionally : Medical Diagnosis was a challenging process.

- Many symptoms are nonspecific
- Process of elimination was used to determine root cause (neither efficient nor exact)

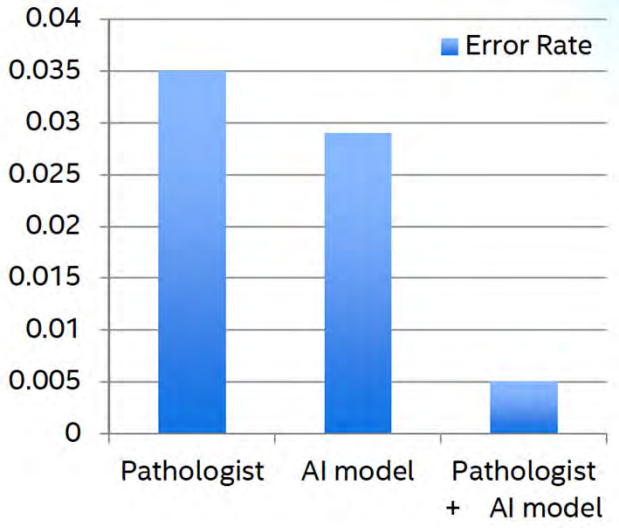
***Now* with AI :** Doctors can provide diagnoses more efficiently and accurately, with the availability of:

- Large medical datasets
- Computer vision algorithms



Example: Breast Cancer, 2016, Harvard Medical School researchers

- Used DL to identify cancer in lymph node images
- Used Convolutional Neural Nets and custom hardware
- AI model combined with humans achieved lower error than either one individually



Healthcare – Treatment Protocol

Traditionally : Doctors would diagnose a condition and recommend a treatment based on what historically worked for most people.

- Some considerations for population/demographics
- Difficult to create custom treatments without extensive research/cost

Now with AI : Doctors can tailor treatments to individual patients.

- Large medical datasets
- ML and DL algorithms
- Population/demographics analysis/simulations

Example: ICU Intervene, MIT Computer Science and Artificial Intelligence Laboratory.

- Uses ICU data, from vitals, labs, notes, to determine how to treat specific symptoms.
- Makes real-time predictions from DL models, to provide recommendations for patients.
- Forecasts predictions into the future (a few hours) compared to traditional methods (a few minutes).
- Predictions can be run on common GPU and CPU hardware.

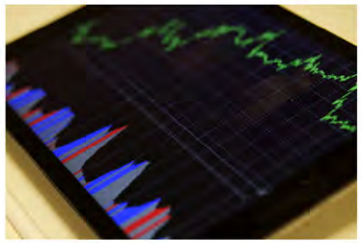
Healthcare – Drug Discovery

Traditionally : Each new drug approval costs over a billion dollars in Research and Development.

- The cost has been doubling every 9 years since 1970
- The drug discovery process can take decades
- 9 out of 10 drug approval attempts fail
- There are currently only 1,500 approved drugs

Now With AI : Companies are leveraging structured and unstructured data with AI, to establish a pipeline of new drug discovery.

- There are 10^{20} possible drug-like molecules
- Massive space for potential discovery



Example: HetioNet drug discovery model, 2016, UCSF, Himmelstein and Baranzini.

- Developed a graph network to encode millions of biomedical reports.
- Used ML to predict probability of treatment efficacy for ~209,000 compound-disease pairs.
- Provided clear pharmacological insights for epilepsy drug discovery and treatment.

Healthcare – Surgery

Traditionally **:** Every type of surgery poses possible risks to the patient.

- Adverse anesthesia effects
- Operational complications

Now with AI : Semi-intelligent computer systems predict surgical steps, identify complications, and warn surgeons about pending challenges.

- Computer "vision" leverages data from laparoscopic and arthroscopic cameras
- Smart systems automate dictation by generating notes during the surgery
- Surgeons can send point-of-view live feeds of the operative site to experts anywhere in the world for real-time advice.

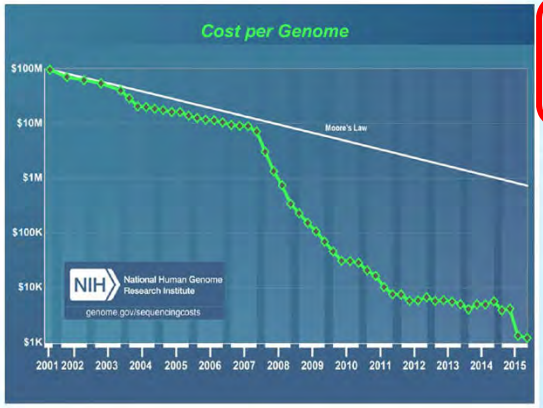
Robot Surgery

https://www.youtube.com/watch?v=H-sOLL9cz_g

Healthcare – Genome Sequencing

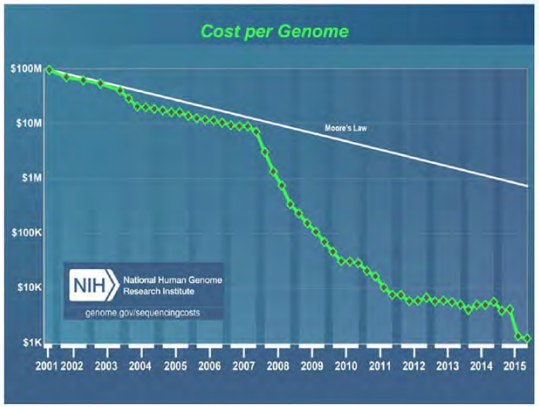
In 2001: Full human sequencing cost $100 million.

- The first genome sequencing took ~13 years



Now with AI **:** Sequence companies are employing AI techniques to reduce cost and increase accuracy.

- Illumina claims that within the near future sequencing will only take 1 hour and cost only $100



Example: Google's DeepVariant* sequencing:

- Leverages massive data sets together with DL to identify all variants
- Accuracy on genome classification: 99.958 %
- DeepVariant* is computationally expensive, but the framework can run on GPU hardware, allowing for a faster learning process
- Availability as open source code promises to revolutionize the industry

Transportation Industry

- Hyperloop
- High-Speed Tunnel Networks
- Self-Driving Cars
- Self-Flying Aircraft

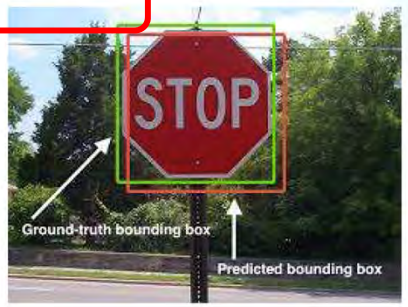
Autonomous Car

Traditionally : Despite having safer cars, the number of deadly car accidents have been on the rise the last few years.

- The leading cause of automobile accidents is human error
- One of the primary sources of traffic jams is each driver acting out of self-interest, that prevents traffic flow
- Part of the population who can't drive: children, the elderly, and the disabled

Now with AI : Self-driving cars are enabled by the latest AI breakthroughs in computer vision.

- Cars identify stop signs, lane lines, and other landmarks via DL tools
- Mapping technology can use computer vision to detect addresses
- Cars triangulate and can use other 3D-sensing technologies, such as LIDAR and RADAR



Example: Waymo, the autonomous vehicle division of Alphabet Inc.

- Waymo has been operating self-driving minivans without a safety driver since October 2017
- Waymo's Carcraft* software accelerated the car's development, with 2.5 billion simulated miles driven in 2016
- The system used DL together with massive data sets collected from self-driving cars on public roads

Automated Trucking

Traditionally **:** There is a shortage of 48,000 drivers nationwide.

- Driver turnover rates at some companies reach 300%
- Truck drivers are twice as likely as other workers to be obese and/or have diabetes
- Truckers are half as likely to have health insurance
- The number of accidents and fatalities have increased in recent years

Now with AI **:** Autonomous trucks can coordinate movements with other trucks.

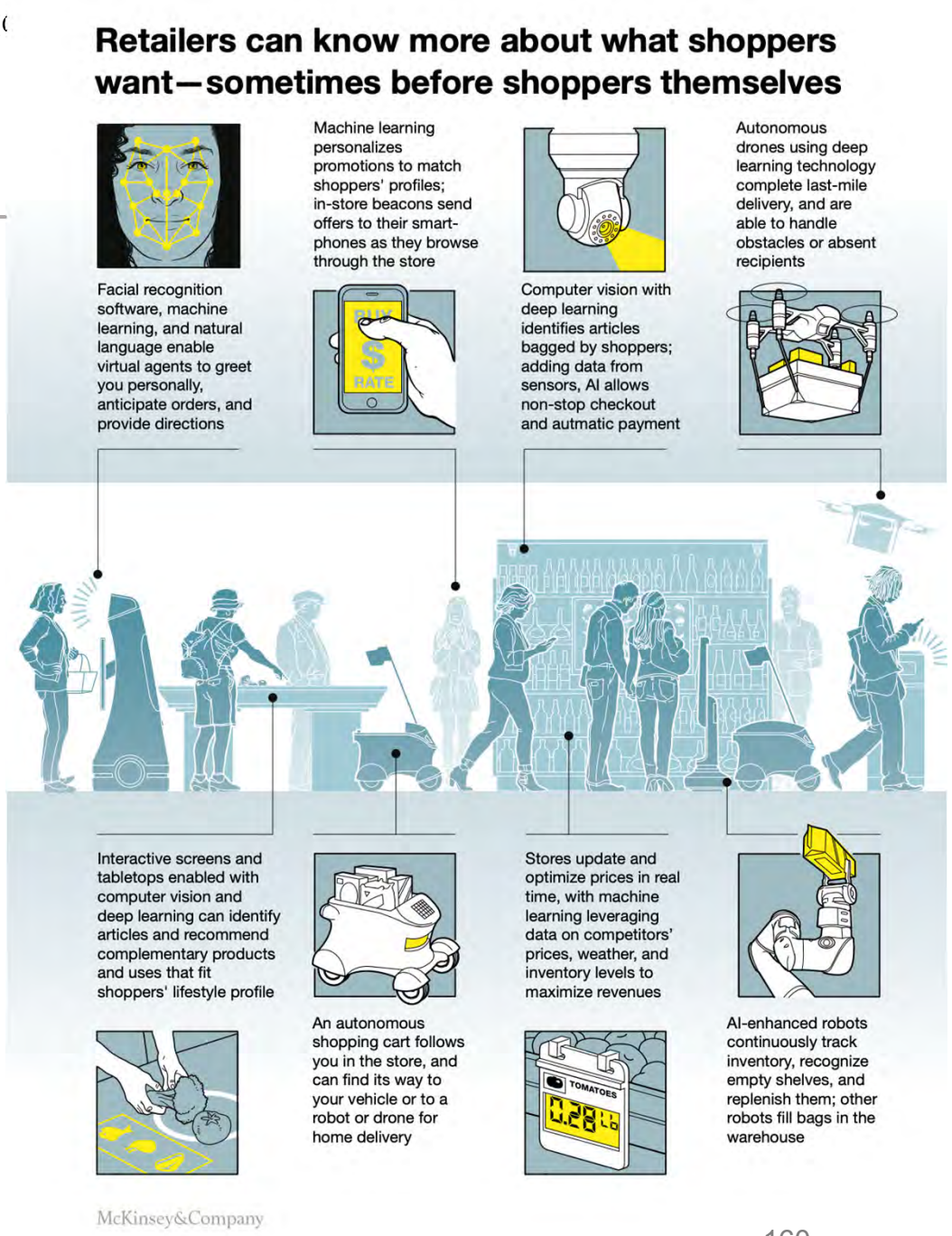
- Save on fuel, and reduce wind-drag and the chance of a collision
- Video, LIDAR, and accelerometers are used to collect detailed data about the truck's surroundings
- Guidance algorithms provide feedback for braking, steering, and throttling commands, based on incoming and historical data

Retail Industry

- Intelligent Shopping Systems
- Robots
- Biometric technologies
- Facial recognition

Retail Industry

- Artificial Intelligence: The Next Digital Frontier
  - 20 percent stock reduction by using deep learning to predict e-commerce purchases.
  - 2 million fewer product returns per year.
  - 30 percent reduction of stocking time by using autonomous vehicles in warehouses.
  - 50 percent improvement in assortment efficiency.
  - 4-6 percent sales increase using geospatial modeling to improve micro market attractiveness.
  - 30 percent online sales increases from the use of dynamic pricing and personalization.



Customer Experience

Traditionally **:** Americans are shifting their spending from material goods to experiences.

- The "Amazon effect": there have been nine major retail bankruptcies in 2017
- Retailers need to become competitive or risk obsolescence
- Balancing "out-of-stock" with "over-stock" trade-off requires great finesse

Now with AI **:** Companies bring experience and optimization to retail shopping.

- AI-powered gift concierge learns your preferences as you engage, and can help predict the appropriate gift to buy
- Leveraging ML-trained agents, companies are providing recommendations via natural language
- Companies using AI via Watson* to monitor factors from weather to consumer behavior, to optimize consumption rate predictions

Example: The North Face and Watson* are combining massive datasets and AI, to bring the brick-and-mortar experience to e-commerce.

- The North Face, with Fluid and IBM Watson*, has launched XPS* - an AI-enabled digital expert that uses a natural language interface to help shoppers.
- XPS curates and filters the available options, so shoppers are more likely to make a purchase

Food Supply Chain

Traditionally : Restaurants use historical data or "gut-feeling" approach to supply chain.

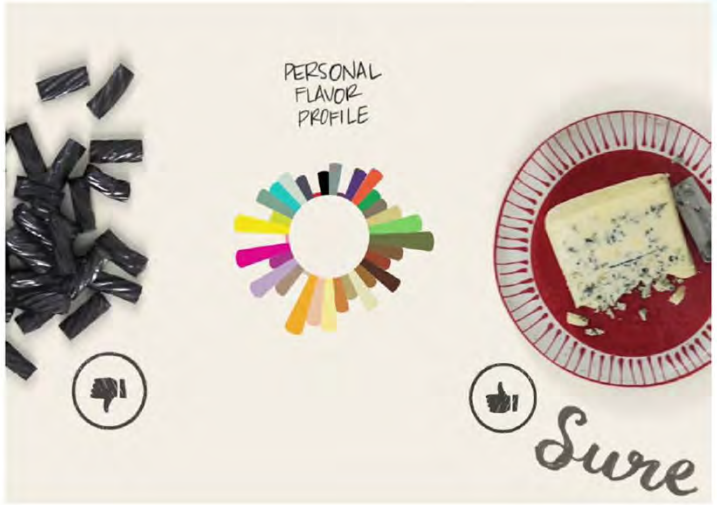
- This can result in excessive waste or food unavailability

Now with AI : Many companies have started to leverage sophisticated algorithms to forecast demand.

- Agents can adjust orders with trading partners in real time, as required for business need

Example: Vivanda's FlavorPrint* program.

- Based on recipes and consumer-provided data, Vivanda maps data to create "digital-taste" identifiers for each consumer
- Providing ML-based recommendations to customers may influence demand
- Shares data with food industry customers, enabling them to improve demand forecasts



Education Industry

- Personalized Learning Platforms
- Individualized Artificial Intelligence Tutors
- Personalized Games
- Crafting a more enjoyable learning experience

Example: Adaptive learning systems, and grading.
• Learning analytics track student performance and provide tailored educational programs.
• Using natural language processing and ML models, AI programs can be used for long answer and essay grading.

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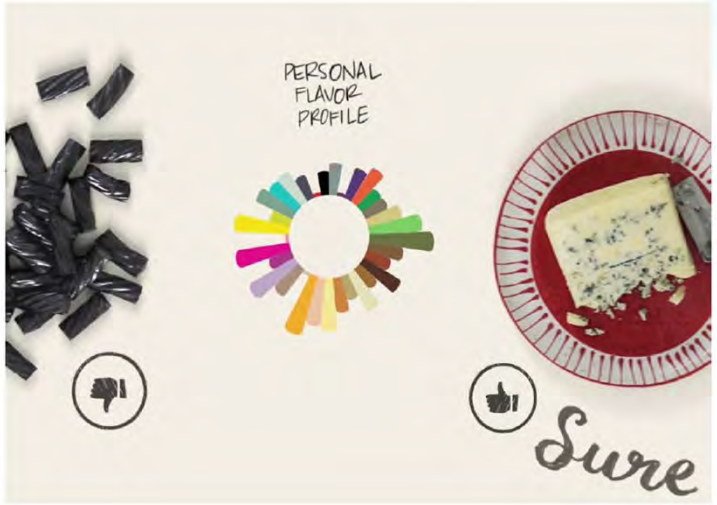


Agriculture Industry

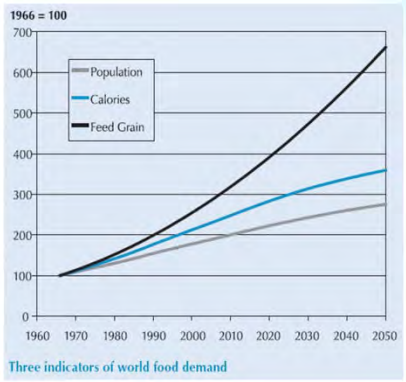
- Agricultural Drones
- Autonomous Tractors
- Vertical Farms

AgTech

Traditionally : The world population is estimated to reach 9 billion by 2050.

- Food production will have to increase by 70% to meet the projected demand.
- Most land suitable for farming is already being used, hence the needed increase must come from higher yields.
- Agriculture must feed the world while not over-straining Earth's resources.

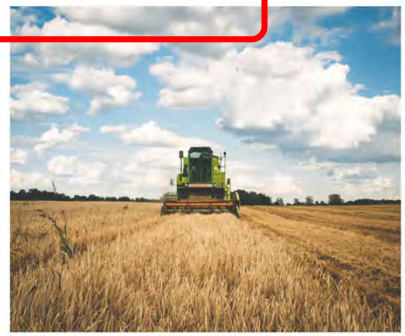
source: www.card.iastate.edu



Three indicators of world food demand

Now with AI : Autonomous robots use computer vision and a produce vacuum system for produce harvest.

- DL-enabled robots are being used to identify and kill weeds.
- Companies have shown 90% herbicide reduction due to "targeted" spray application.
- AI-driven genome sequencing advancements enables crop "genome" editing.



Example: TellusLabs yield predictions.

- Uses ML together with weather and other historical data to forecast yields.
- Leverages cloud-based GPUs for DL on satellite images.
- TellusLab's predictions have shown to be consistently more accurate than the USDA.
- Came within 1% of predicting corn and soybean yields in 2017.

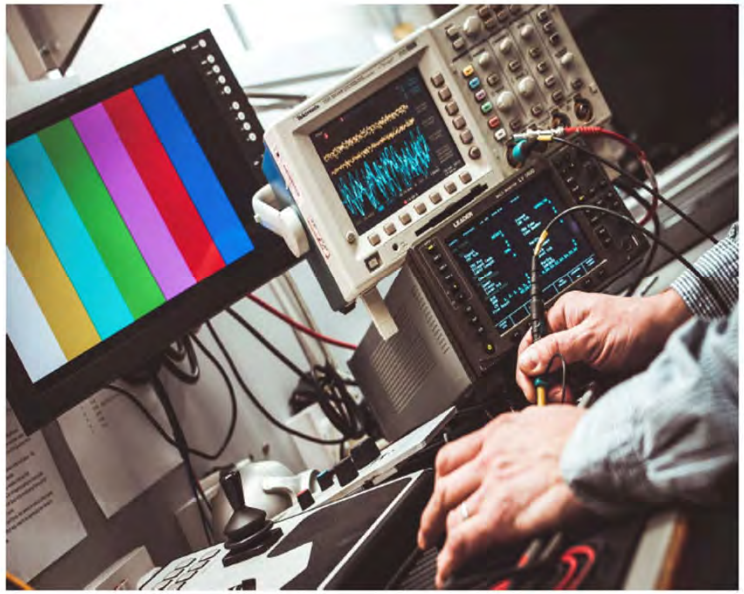
I AM AI

https://www.youtube.com/watch?v=gzGkC_o9hXI

AI for Music Generation

Example: "I AM AI", first album released in 2017 to be generated by AI – with professional musicians and DL technology.

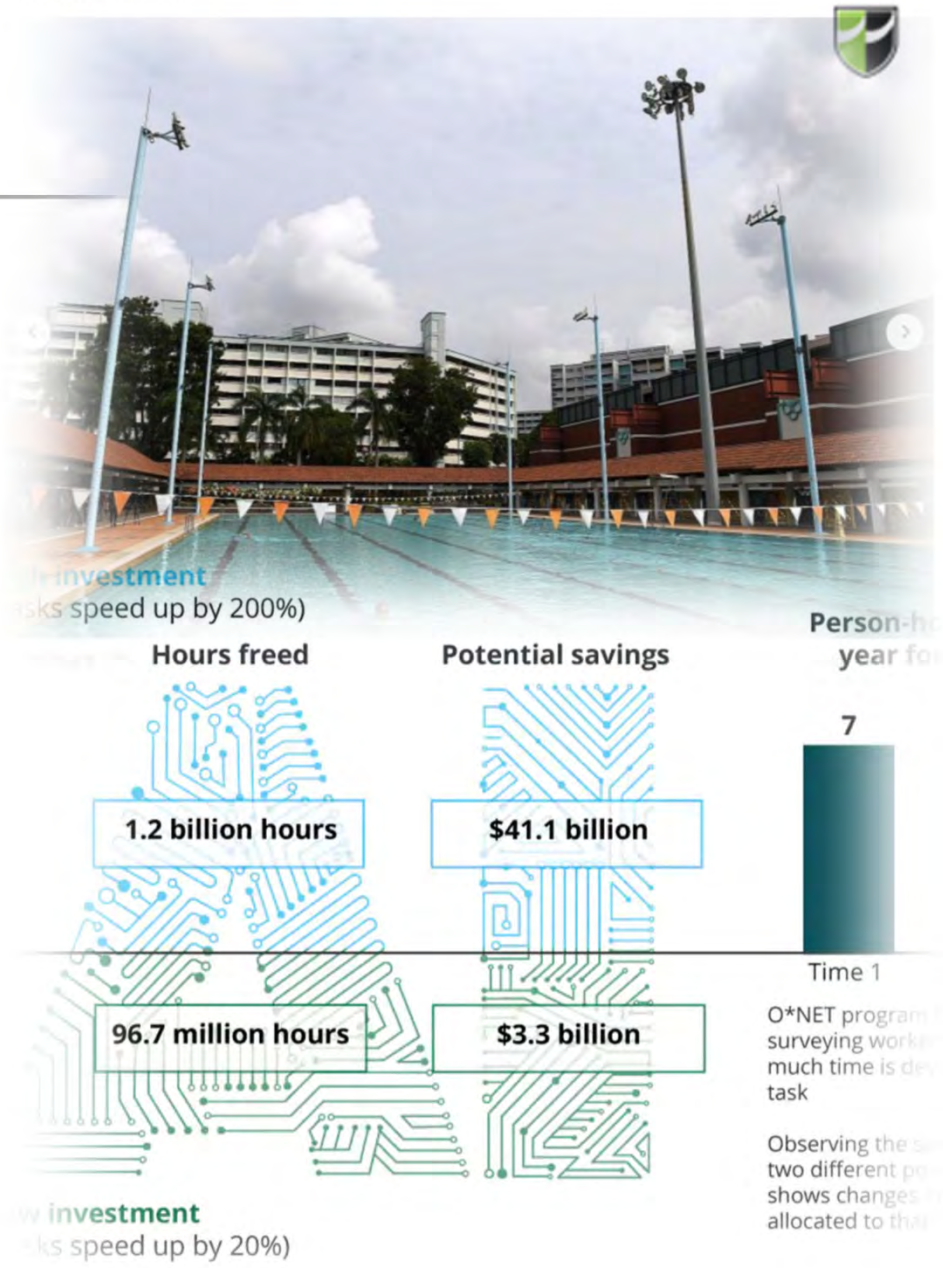
- Music generation is possible due to special DL algorithms that are designed for sequential data.
- The models learn musical patterns based on learning from large musical datasets.
- Raw music files can be processed on cloud-based computer power, making DL on these datasets possible.



The instrumentation was composed with artificial intelligence, lyrics and vocal melodies written by by Taryn. Let us know what you think in the comments!

Governments

- Public Safety and security
- Bureaucratic Efficiency



Smart Cities

Traditionally **:** As of 2008, for the first time in history, half of the world's population resides in cities.

- There are heightened demands on scarce resources.
- Simultaneously, a large part of existing infrastructure is underutilized or not being used efficiently.

Now with AI **:** AI techniques are used to analyze photo and video data to perform studies of pedestrian and traffic trends.

- Adaptive signal control: allows traffic lights to tailor their timing based on real-time data.
- With license plate recognition, and DL technology, cities can not only optimize parking but can also track criminals.

Example: AT&T reimagines smart cities

- AT&T developed a framework to help cities integrate Internet of Things (IoT) sensors with AI.
- Remotely monitor the condition of roads, bridges, buildings.
- Assist with public safety.
- Notify police if gunfire has gone off, by using sound detection.

Cybersecurity

Example: Deep Instinct

- Uses GPU-based neural network to achieve 99% detection rates for even the most advanced cyber attacks.
- DeepInstinct's DL models have the ability to detect patterns - mostly designed by humans - enabling the prediction of pending cyber attack.

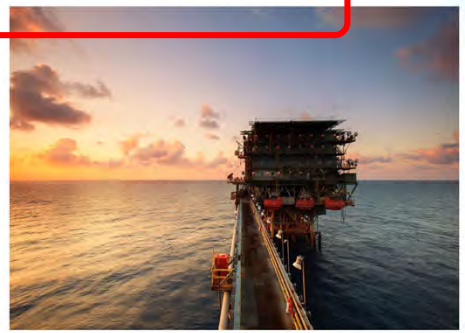
Oil and Gas

Traditionally : Shrinking oil reserves force companies to operate in remote and possibly hostile areas.

- Price has fallen dramatically in recent years.
- Forcing company layoffs and drastic budget cuts.
- Ultimately, companies are in great need of optimizing operations and cost.

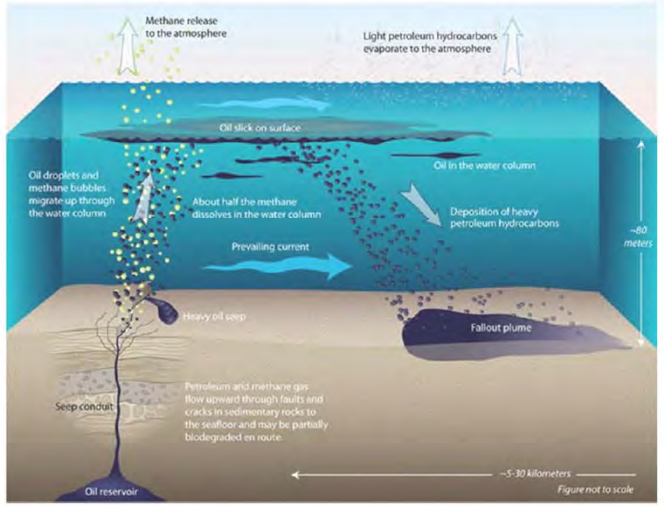
Now with AI : AI uses economic, political and weather data to forecast optimum production locations.

- Drilling is still an expensive and risk-prone endeavor.
- ML, with seismic, thermal and strata data, can help optimize the drilling process.



Example: ExxonMobile and MIT developing "submersible" robots for exploration.

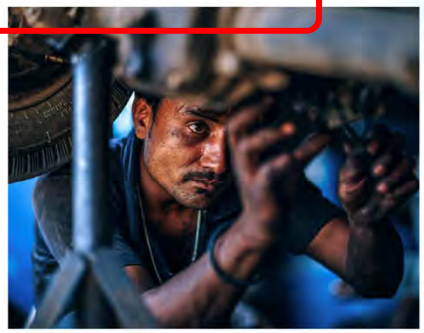
- AI robots are used in ocean exploration to detect "natural seep".
- Robots are trained via DL techniques and learn from their mistakes.
- Simultaneously protect the ecosystem and detect new energy resources.



Preventive Maintenance

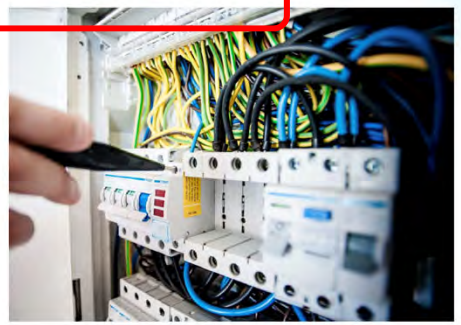
Traditionally **:** Relied on historical data to provide basis for preventative maintenance schedule.

- Conservative approach: parts were replaced well before failure, and thus financially inefficient.
- Flawed due to inability to predict new failure modes.



Now with AI **:** Internet of Things (IoT) sensors help to optimize maintenance scheduling.

- Part replacement schedule is optimized by assessing anomalies and failure patterns.
- Safety and productivity can increase exponentially.



Example: AI with General Electric.

- GE is the industry leader for Internet of Things (IoT) sensor installations on engines and turbines, and plans to have 60,000 engines connected to the internet by 2020.
- Computer vision cameras and reinforcement learning algorithms find tiny cracks or damage.
- Sensor data and AI allows GE to track performance and optimize part replacement.

Fault Detection

Example: Computer vision for fault detection on solar panels.

- DL algorithm trained on labelled data of correctly manufactured vs. flawed panels
- Reduced the need for human inspection by 66% compared to historical need

Automate Garment Industry

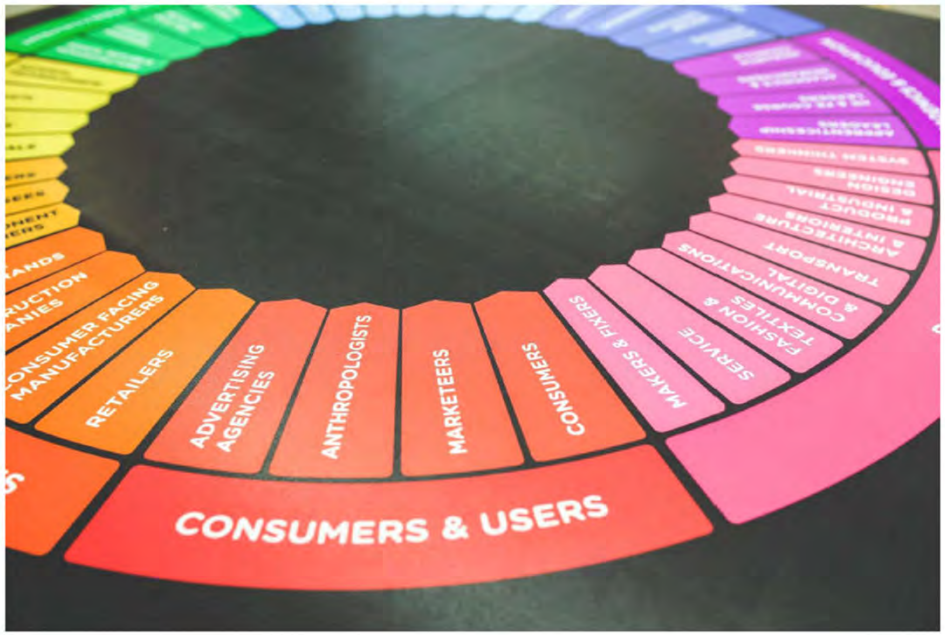
Example: SoftWear Automation's "*sewbots*".

- Computer vision is used to track fabric at the thread level.
- Eliminates need for human seamstress / seamster.
- Allows designers to create garments that were previously thought to be too complicated or specialized to construct.

AI and Customer Service

Example: Bot assistants and customer service agents

- AI Augmented messaging.
- AI for sorting and routing inquiries.
- AI enhanced customer phone calls.
- Some companies have used AI to fully automate customer service.



AI and Next Gen Gaming

Now with AI : Forza 5 Motorsport* uses its "Drivatar" AI system to learn how to drive in the style of other players in the game.

- Neural networks are used to train characters to walk and run realistically.
- Reinforcement Learning (RL) is a technique used throughout gaming.

Quiz

Step 1: Scan the following QR code
Get ready for the quiz to start

https://bit.ly/kw_poll

Step 2: Enter your name you would like to appear alongside your responses.

Step 3: Wait for the quiz to begin…

What's Next

ONLINE

› DataCamp
https://www.datacamp.com/

› Edx
https://www.edx.org/

› Udemy (freemium course)
https://t.me/freecourse

SHORT COURSES

› 1-4 days short courses
- AI
- Data Analytics
- IT Security
- DevOps
- Software Development
- New/Digital Media

https://www.rp.edu.sg/soi/lifelong-learning

PART TIME FULL QUALIFICATIONS

› Specialist Diplomas
- Applied AI
- Business Analytics
- Cloud Architecting & Management

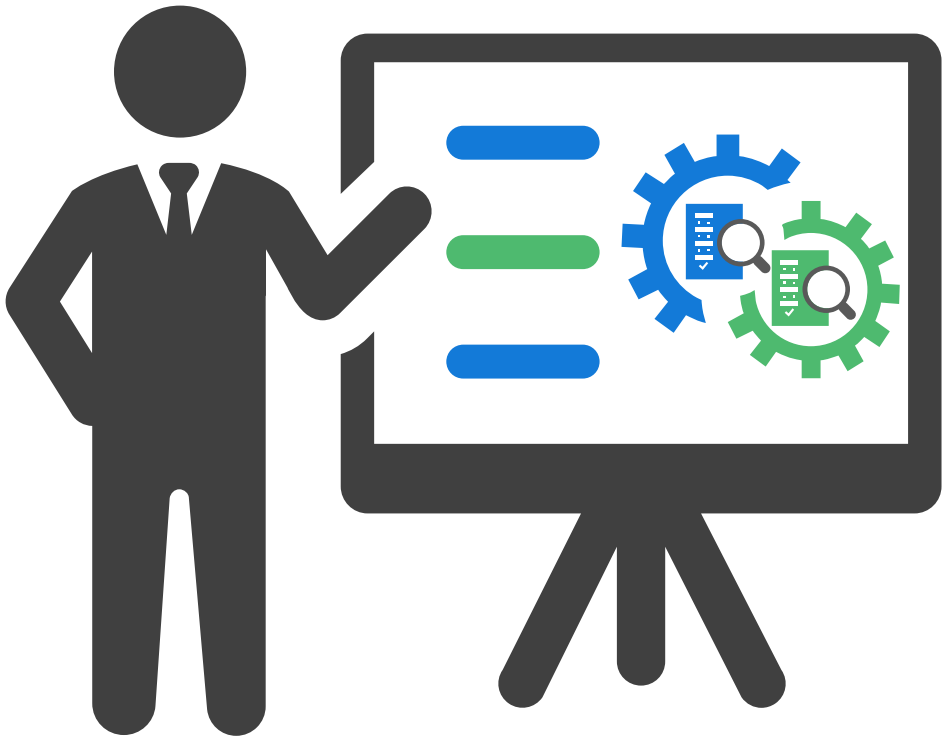
https://www.rp.edu.sg/soi/lifelong-learning

FULL TIME

› Tech Immersion and Placement Programme in Applied Artificial Intelligence

https://www.rp.edu.sg/ace/short-course/Detail/tipp-applied-artificial-intelligence

Summary



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Source code:

Thank you