Artificial intelligence and Machine Learning

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Why must Humans do all the thinking?

World's most concerning issues

1. Climate change / destruction of nature
2. Large scale conflict / wars
3. Inequality (income, discrimination)
4. Poverty
5. Religious conflicts
6. Government accountability and transparency / corruption
7. Food and water security
8. Lack of education
9. Safety / security / wellbeing
10. Lack of economic opportunity and employment

World Economic Forum, 2018

The Human Brain

- 100,000,000,000 Neurons
- 10,000,000,000,000 Synapses
- The most complex machine known by to man
- Studied by
  - Philosophers, Psychologists, Surgeons
  - Neuroscientists
  - Theoretical Neuroscientists
  - Neuromorphic Computing Researchers
  - Cognitive Neuroscientists
  - Molecular Neuroscientists

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Artificial Intelligence
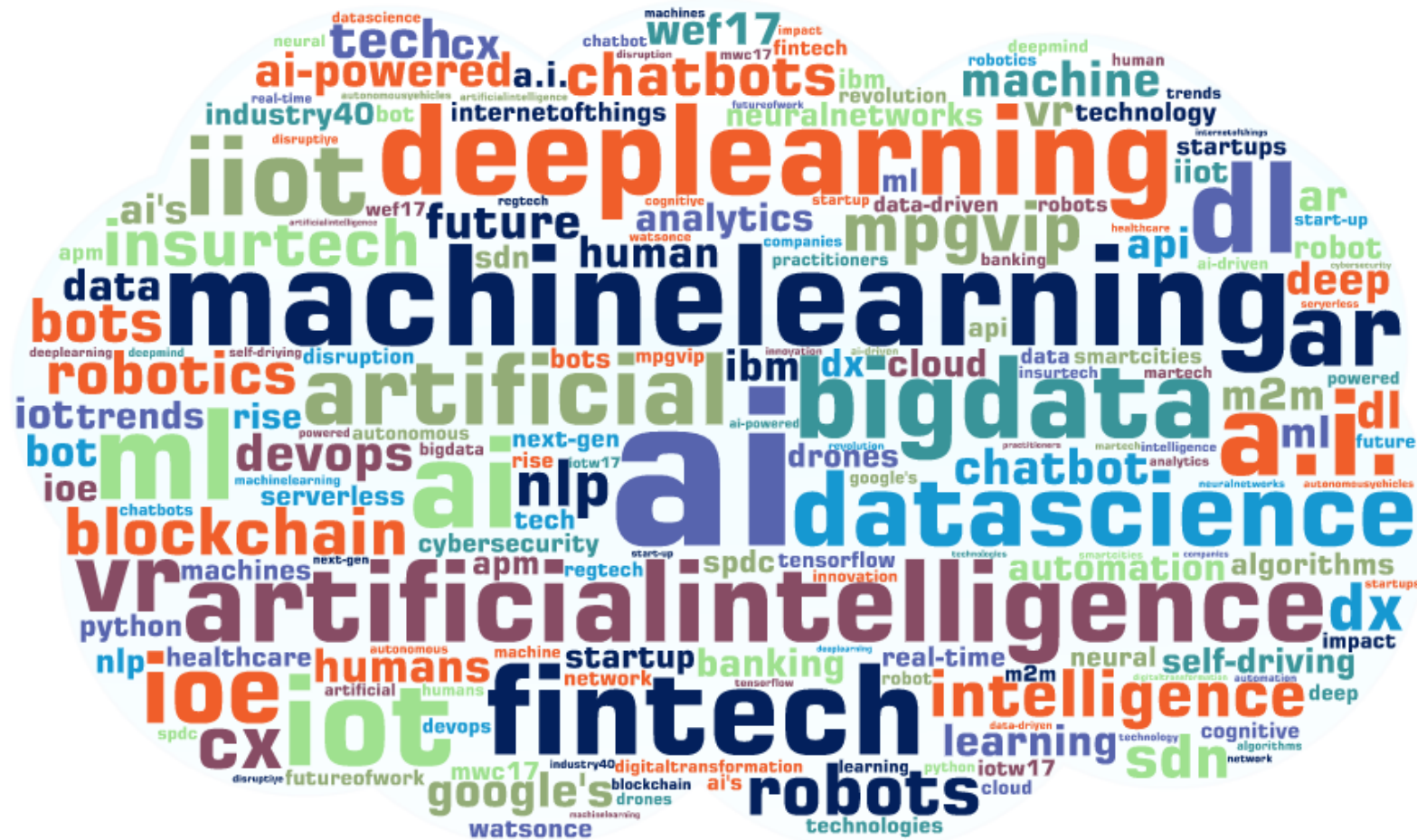
What is Artificial Intelligence

A system's ability to:

- correctly interpret external data,

- to learn from such data,

- and to use those learnings to achieve specific goals and tasks through flexible adaptation
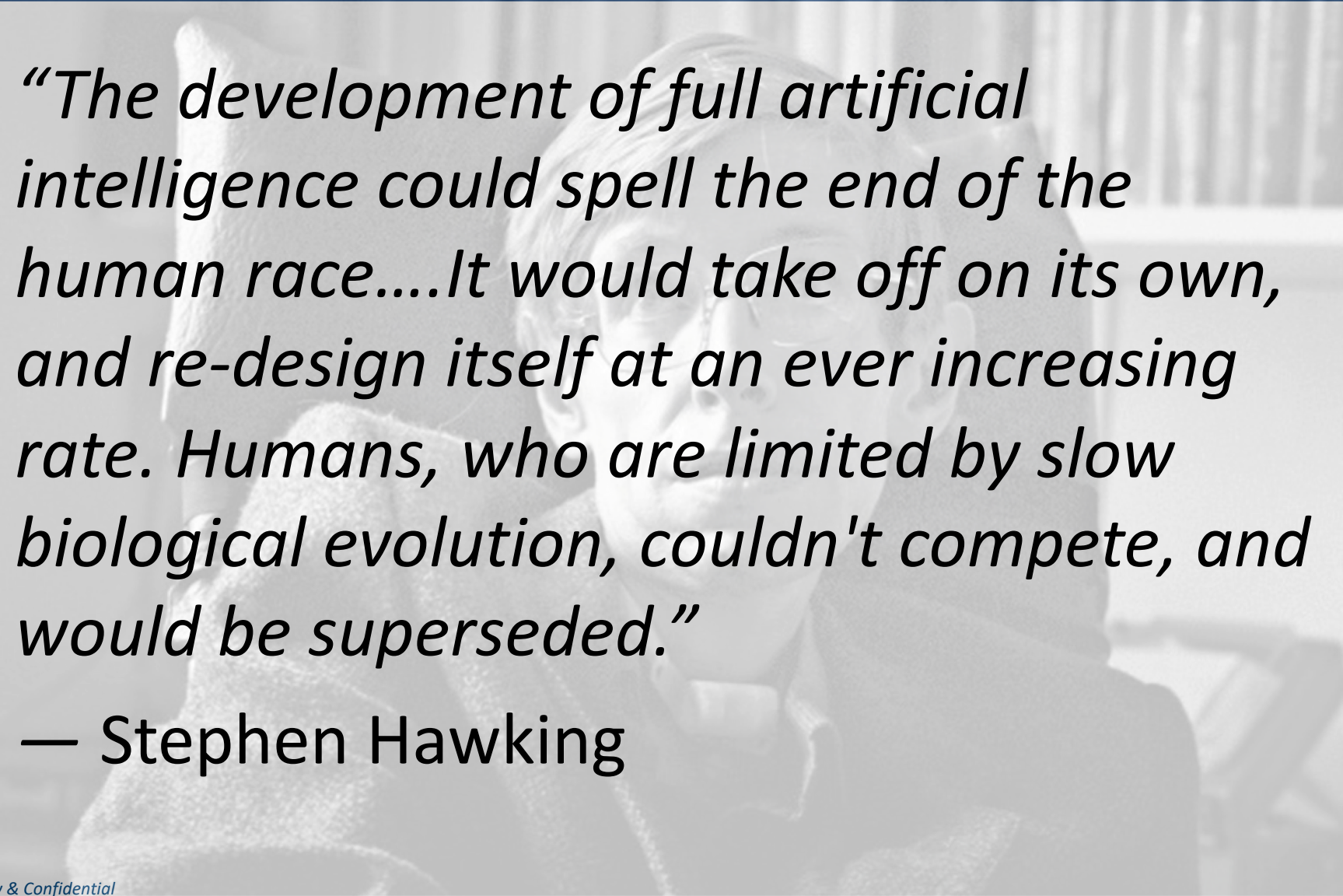
Why Pursue Artificial Intelligence?

- Acts as a multiplier of human ingenuity

- Makes our life better, as it does repetitive (drudgery-inducing) tasks way faster and more efficient than we could ever do so.

- Provides insights, options (and ultimately decisions) we otherwise wouldn't get ourselves

Artificial <u>General</u> Intelligence

- Could successfully perform <u>any</u> intellectual task that a human being can.

- Not currently close, but at least 45 active R&D projects. Largest 3 being DeepMind (Google), The Human Brain Project (EU) and OpenAI (Musk)

- Achieving AGI has been labeled "The Singularity".

- Experts generally agree this will happen this century.

"The development of full artificial intelligence could spell the end of the human race….It would take off on its own, and re-design itself at an ever increasing rate. Humans, who are limited by slow biological evolution, couldn't compete, and would be superseded."

— Stephen Hawking

Historical highlights if A.I.

- Started in 1957
- 1966 –Eliza –A machine that could respond to humans via textual responses
- 1968 - HAL 9000 from *"2001 a Space Odyssey"*
- 1980 – XCON gives rise to Expert Systems
- 1991 – Birth of the Internet
- 1997 – Deep Blue beats Gary Kasparov in Chess
- 2011: Watson on Jeopardy, Siri
- 2014: Alexa

Critics: AI Winter is Coming!

Industrial Revolution

- First Industrial Revolution (Late 1700's) – Steam engine lead to factories

- Second Industrial Revolution (Late 1800's) – Mass Production in Steel, Oil and Electricity,

- Digital Revolution (Late 1900's) – Semiconductors, Personal Computers and the Internet

- Fourth Industrial Revolution (Now) – Artificial Intelligence, Robotics and the Internet of Things blurs the line between physical, digital and biological spheres

Klaus Schwab, World Economic Forum, 2016

Forbes (February 2019)

As humanity stands on the brink of a technology triggered information revolution, the scale, scope and complexity of the impact of intelligence evolution in machines is unlike anything humankind has experienced before. As a result, the speed at which the ideas, innovations and inventions are emerging on the back of artificial intelligence has no historical precedent and is fundamentally disrupting everything in the human ecosystem.

In addition, the breadth, depth and impact of this intelligence evolution on furthering of ideas and innovations across cyberspace, geospace and space herald the fundamental transformation of entire interconnected and interdependent systems of basic and applied science: research and development, concept to commercialization, politics to governance, socialization to capitalism, education to training, production to markets, survival to security and more.

Examples of AI

- Fully automated vehicles
- Personalized medical treatment
- Robot-assisted surgery
- Deep Fake video persona hacking
- Predicting what music you'll want to hear
- Using Facebook to diagnose medical conditions
- When will my food delivery arrive?
- Optimizing soil health and crop yields

Why Now?

- Market pressures
- Faster computers – GPUs and purpose-built chips
- Big data–oriented data management platforms
- Dramatically more data captured and available
- Democratization of the Cloud–Drives down costs, increases availability of storage and algorithmic capabilities
- Commercialization – Computer giants are "all-in"

Explosive Growth in AI

- AI and machine learning have the potential to create an additional $2.6T in value by 2020 in Marketing and Sales, and up to $2T in manufacturing and supply chain planning.

  Source: McKinsey Global Institute

- The market for Cognitive and Artificial Intelligence systems will reach $77.6B in 2022, more than three times the $24.0B spent in 2018

  Source: IDC Worldwide

- 47% of organizations participating in a recent survey say they have either scaled up and industrialized machine learning or are moving projects into production.

  Source: HFS Research & KPMG
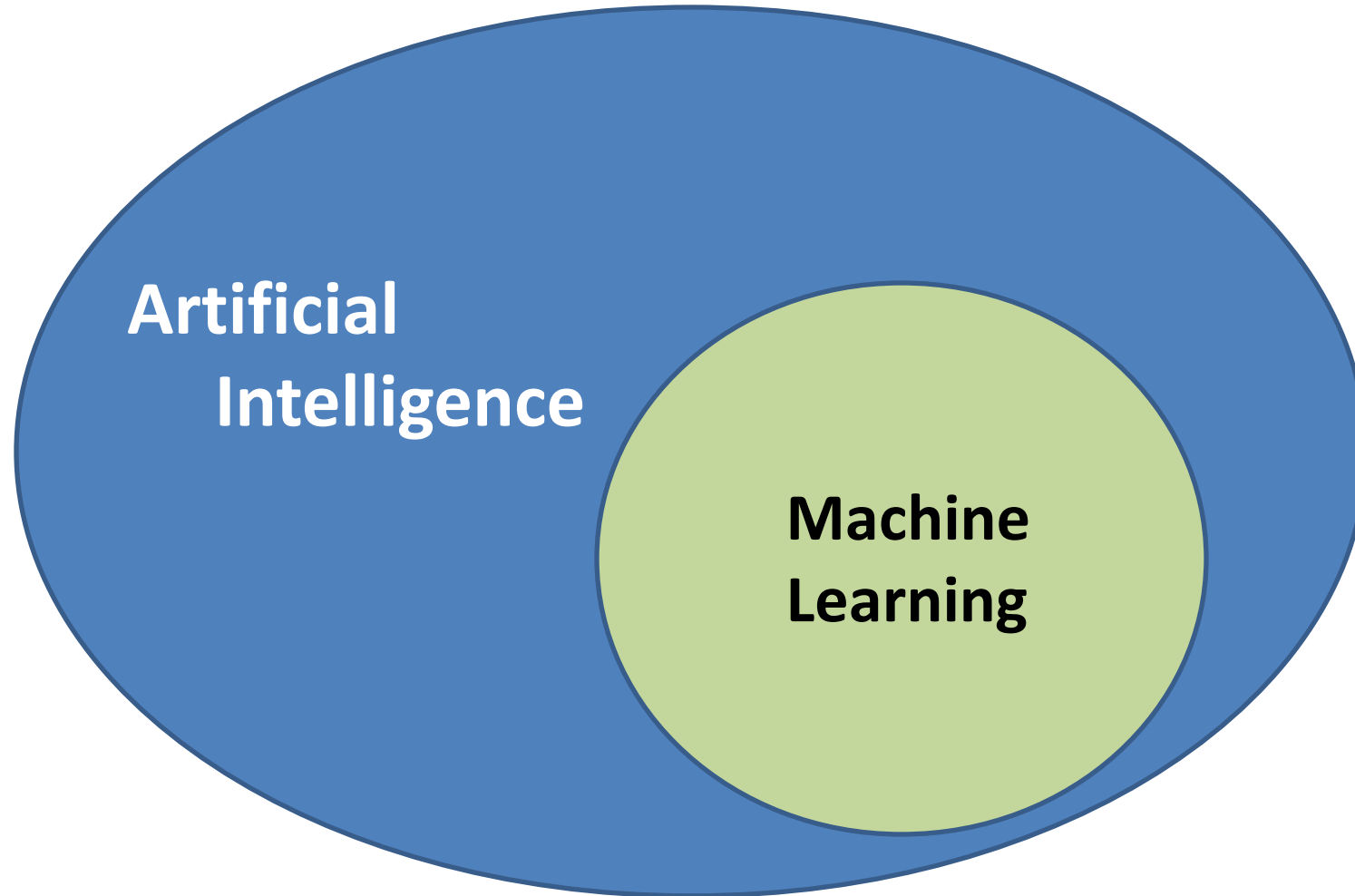
Machine Learning vs AI

Artificial Intelligence

Machine Learning

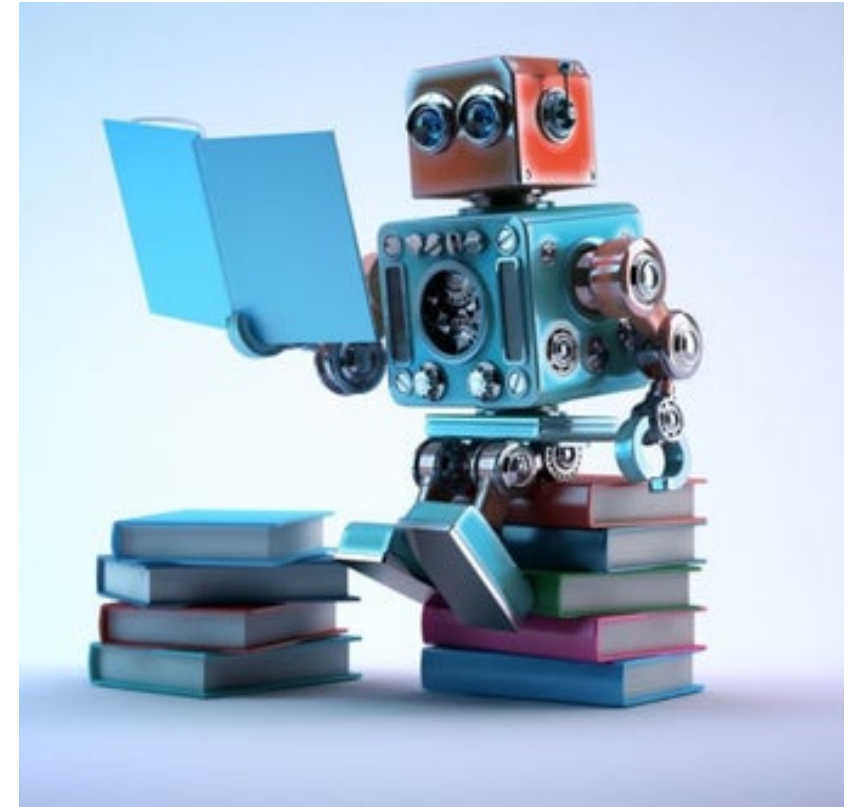# Other Types of AI
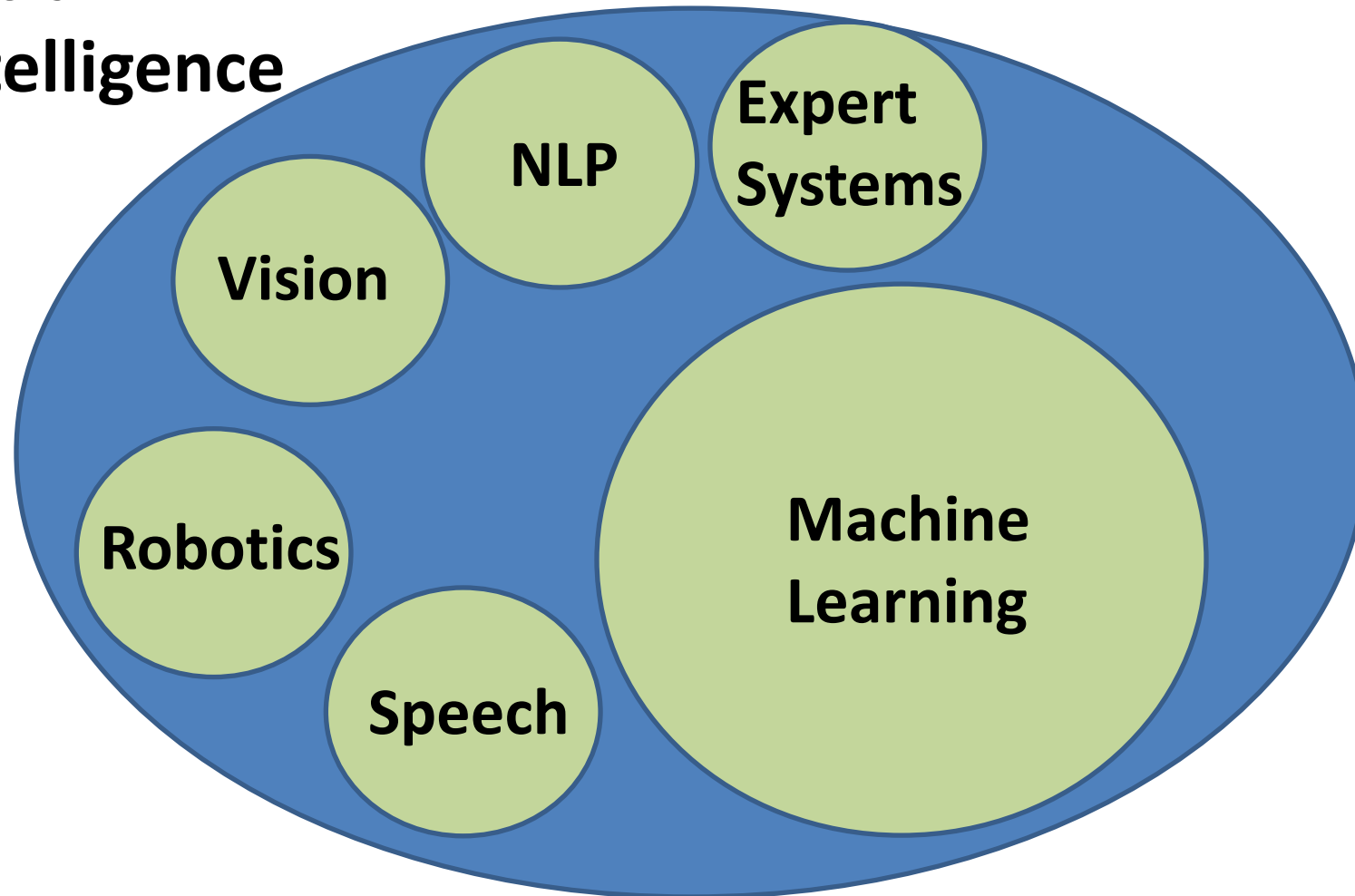
Machine Learning vs AI

- We don't feed the computer rules or instructions, we allow it to learn from examples and experience

- Give it examples – Thousands, or millions, and it will then extrapolate to how it should treat the next one,

- Dynamic – Can modify itself based on more data

Differing Learning Approaches
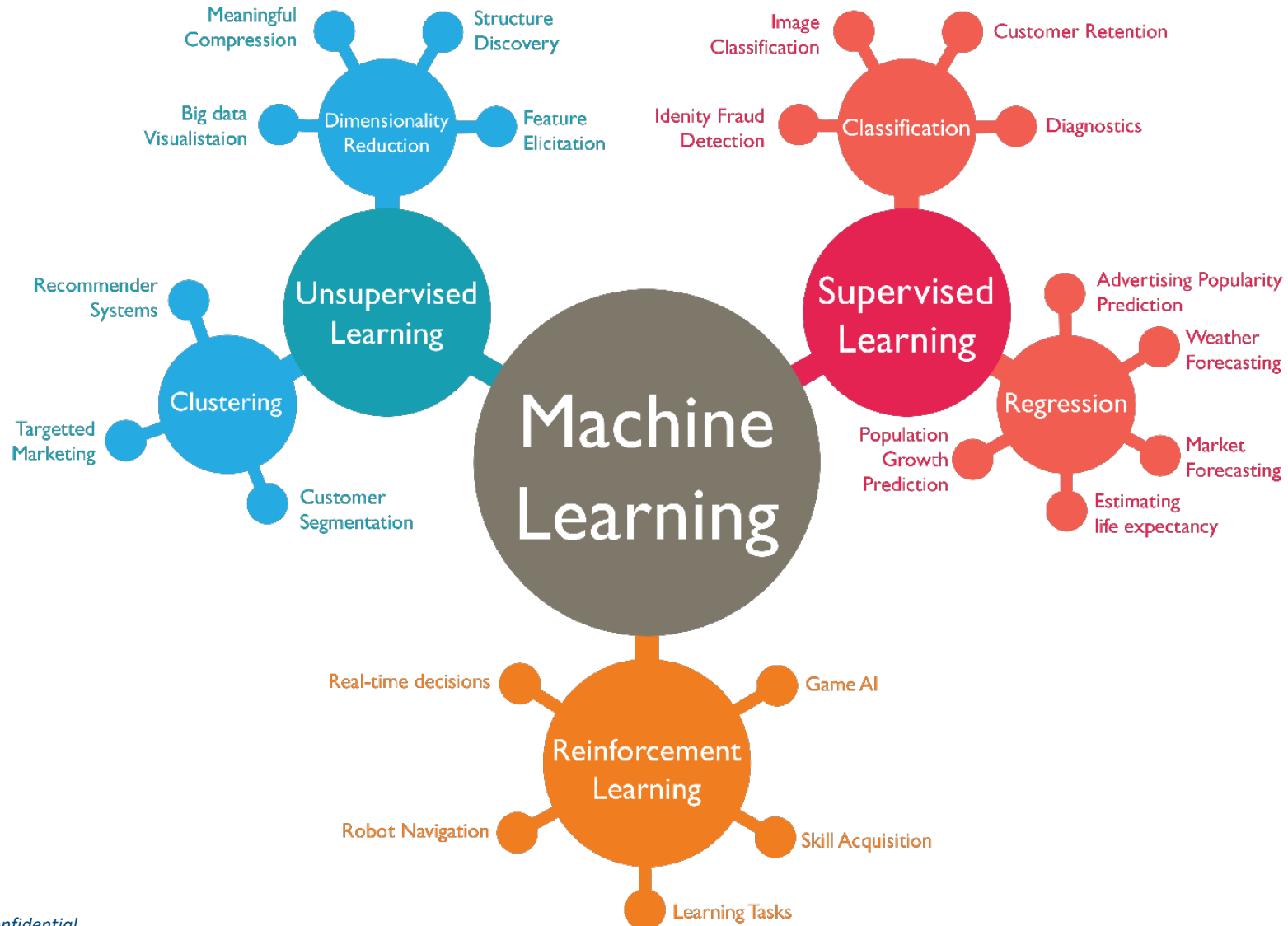
Example Algorithms for Machine Learning

- Linear Regression
- Logistic Regression
- Classification and Regression Trees (CART)
- Naïve Bayes
- K-Nearest Neighbors
- Apriori
- Kmeans
- Neural Network Regression

- Principle Component Analysis
- Random Forests
- Adaptive Boosting
- Principal Component Analysis
- Latent Dirichlet Analysis
- Scalable Boosted Decision Trees
- Decision Jungles

Choosing an algorithm

Microsoft Azure Machine Learning: Algorithm Cheat Sheet
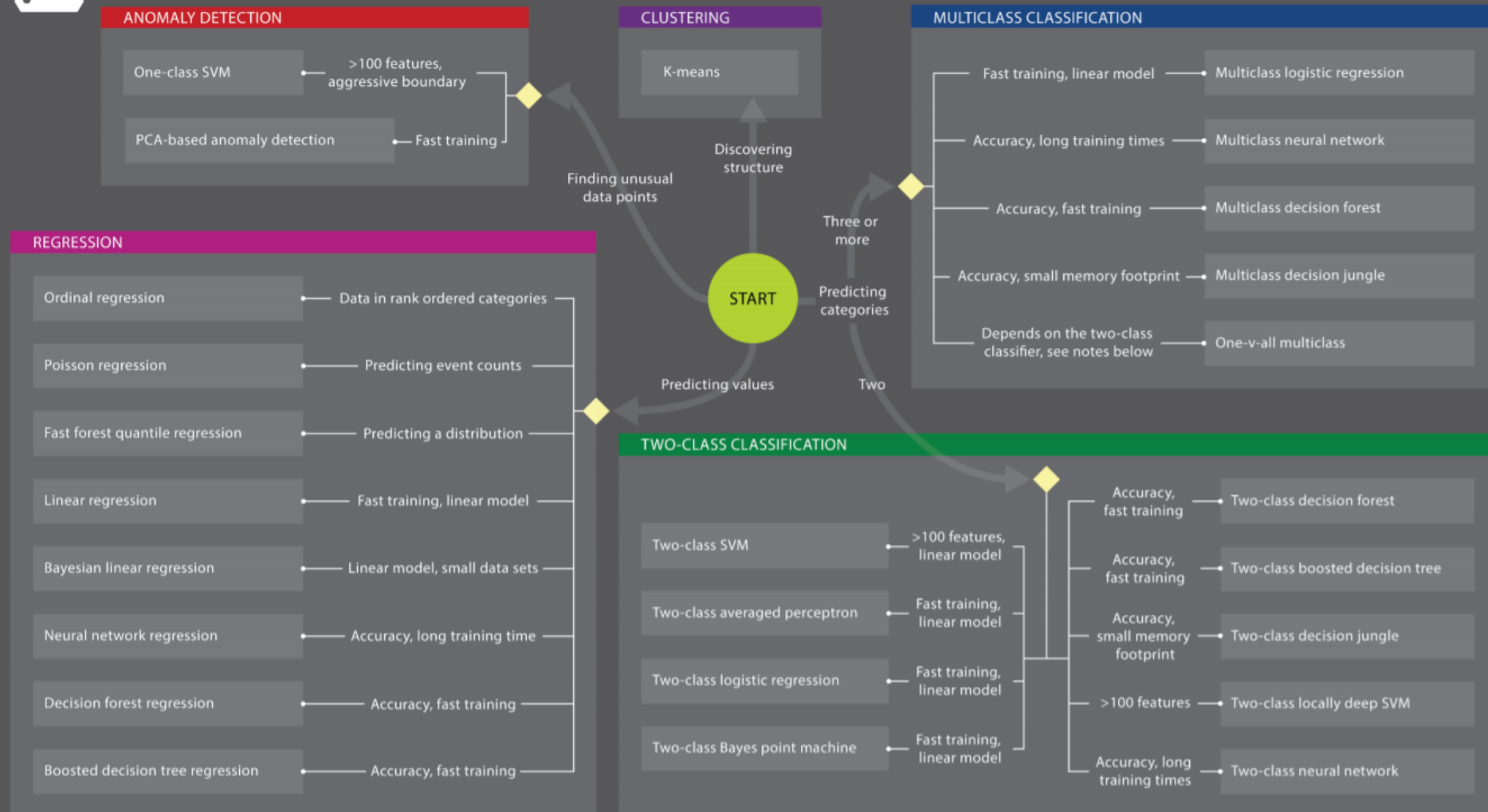
This cheat sheet helps you choose the best Azure Machine Learning algorithm for your predictive analytics solution. Your decision is driven by both the nature of your data and the question you're trying to answer.

ANOMALY DETECTION
- One-class SVM → >100 features, aggressive boundary
- PCA-based anomaly detection → Fast training

CLUSTERING
- K-means

MULTICLASS CLASSIFICATION
- Fast training, linear model → Multiclass logistic regression
- Accuracy, long training times → Multiclass neural network
- Accuracy, fast training → Multiclass decision forest
- Accuracy, small memory footprint → Multiclass decision jungle
- Depends on the two-class classifier, see notes below → One-v-all multiclass

REGRESSION
- Ordinal regression → Data in rank ordered categories
- Poisson regression → Predicting event counts
- Fast forest quantile regression → Predicting a distribution
- Linear regression → Fast training, linear model
- Bayesian linear regression → Linear model, small data sets
- Neural network regression → Accuracy, long training time
- Decision forest regression → Accuracy, fast training
- Boosted decision tree regression → Accuracy, fast training

TWO-CLASS CLASSIFICATION
- Two-class SVM → >100 features, linear model
- Two-class averaged perceptron → Fast training, linear model
- Two-class logistic regression → Fast training, linear model
- Two-class Bayes point machine → Fast training, linear model
- Accuracy, fast training → Two-class decision forest
- Accuracy, fast training → Two-class boosted decision tree
- Accuracy, small memory footprint → Two-class decision jungle
- >100 features → Two-class locally deep SVM
- Accuracy, long training times → Two-class neural network

START
- Discovering structure
- Finding unusual data points
- Three or more / Predicting categories / Two
- Predicting values

Artificial Neural Network

- Can sort through complex and messy data and model it to make it useful

- Show me thousands of pictures of cats and tell me that they are cats (labeling) and I'll develop the ability to recognize a cat, without having any real information about what a cat "is"
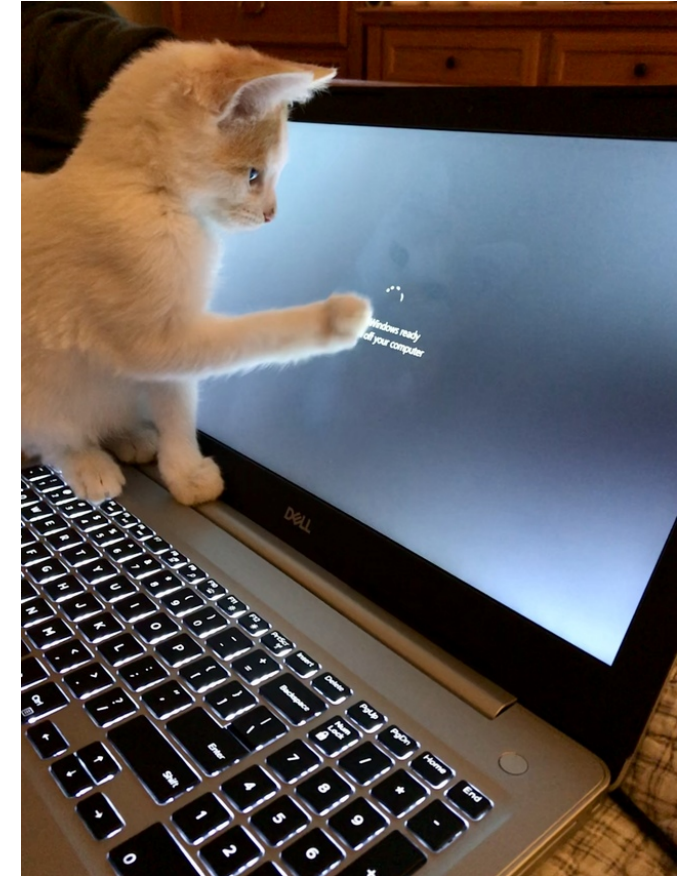
Deep Learning

- Multiple levels of neural networks, including potentially unstructured, unlabeled data, where each layer feeds the subsequent layer

- "I'm 95% sure these pictures are all of domesticated female cats that live indoors, while this group is all male dogs that are happy and living outdoors"
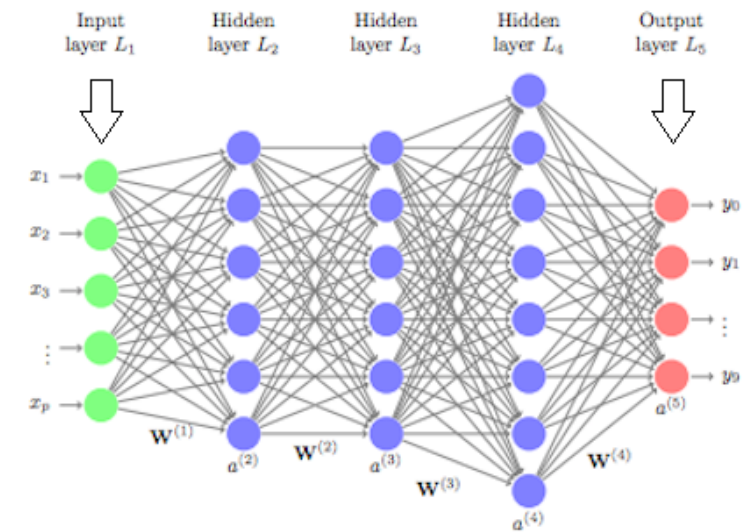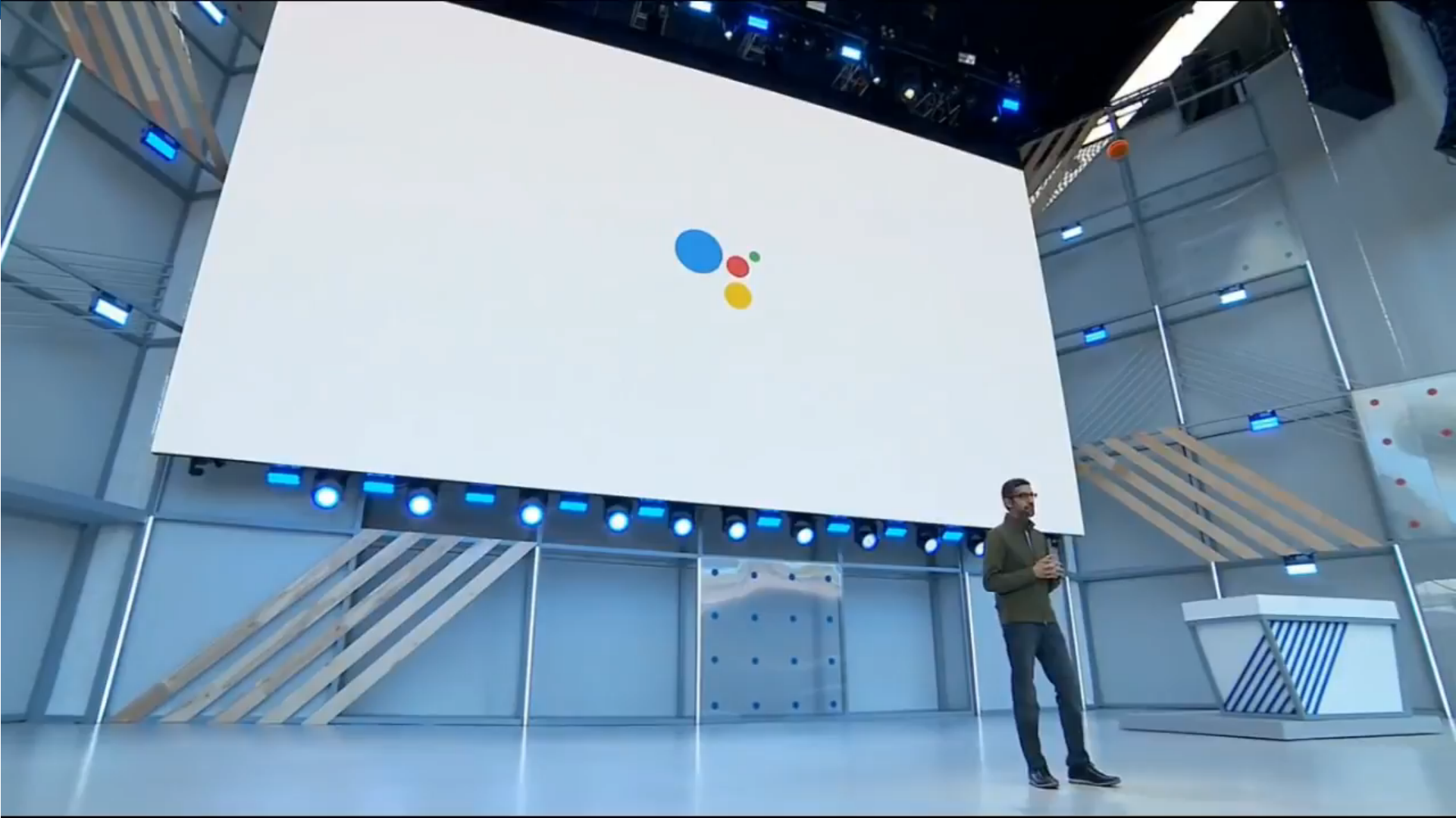
Natural Language Processing

- Smart Virtual Assistants - Alexa, Siri, Google Assistant, etc.

- Chatbots

- Difficulties come in understanding context – "Steve Jobs ran Apple like an artist"

- Tremendous growth coming in "human-ness" of machine initiated speech (i.e., natural language generation)

Machine Learning vs AI

Sample uses for Machine Learning

- Identifying Refund Fraud
- Refunds held for approval – the machine can help
- Making decisions on Return exceptions
- Collections – Whom to go after first or…how to identify them well before they go to Collections
- Customer Service – I know why you're calling and here's your answer. Text you with your answer before you call.

Sample Uses for Other types of AI

- Identifying unhappy callers, or escalating call situations
- Chatbots – Fielding questions for you live or online
- Manual Collections – Conversing with your delinquent taxpayers
- Using social media sentiment analysis to identify likely non-filers and then using targeted nudge marketing to deter in advance

Impacts on Your Business

- Drives costs down, but requires upfront investment

- Leverages your top people – Let the machines learn from your best!

- Need to build knowledge about AI and trust for results it delivers

- Legislative impact – e.g., can machines make decisions?

- Staffing – There'll be reskilling opportunities

- Need for Data Scientists

What will drive continued growth

- Quantum computing will exponentially advance computing power

- Inter-relationships between techniques drives materially better results

- The Artificial Intelligence global arms-race

Questions