DEEP LEARNING IN FINANCE

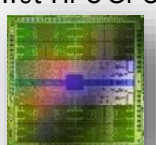
TEN YEARS OF GPU COMPUTING

2006 — CUDA Launched

NVIDIA CUDA

2008 — World's First GPU Top500 System

2010 — Fermi: World's First HPC GPU



2010 — Oak Ridge Deploys World's Fastest Supercomputer w/ GPUs

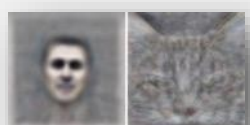
2012 — Discovered How H1N1 Mutates to Resist Drugs

2012 — AlexNet beats expert code by huge margin using GPUs

IMAGENET

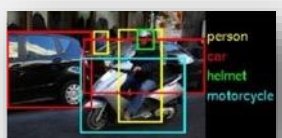
2014 — World's First Atomic Model of HIV Capsid

2014 — Stanford Builds AI Machine using GPUs



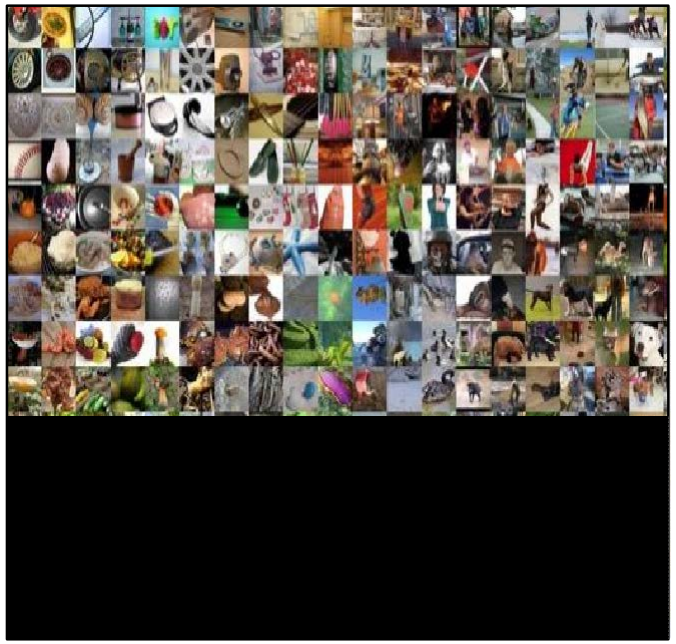
2015 — World's First 3-D Mapping of Human Genome

2015 — Google Outperforms Humans in ImageNet

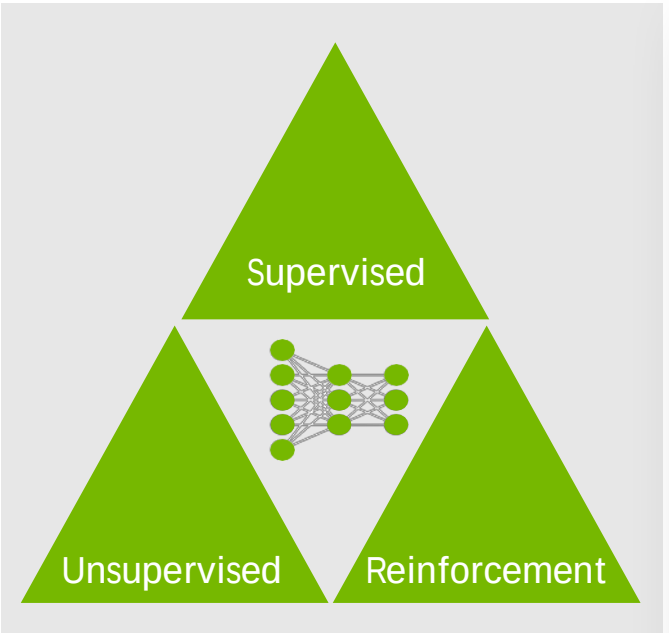


2016 — GPU-Trained AI Machine Beats World Champion in Go

THE DEEP LEARNING RECIPE



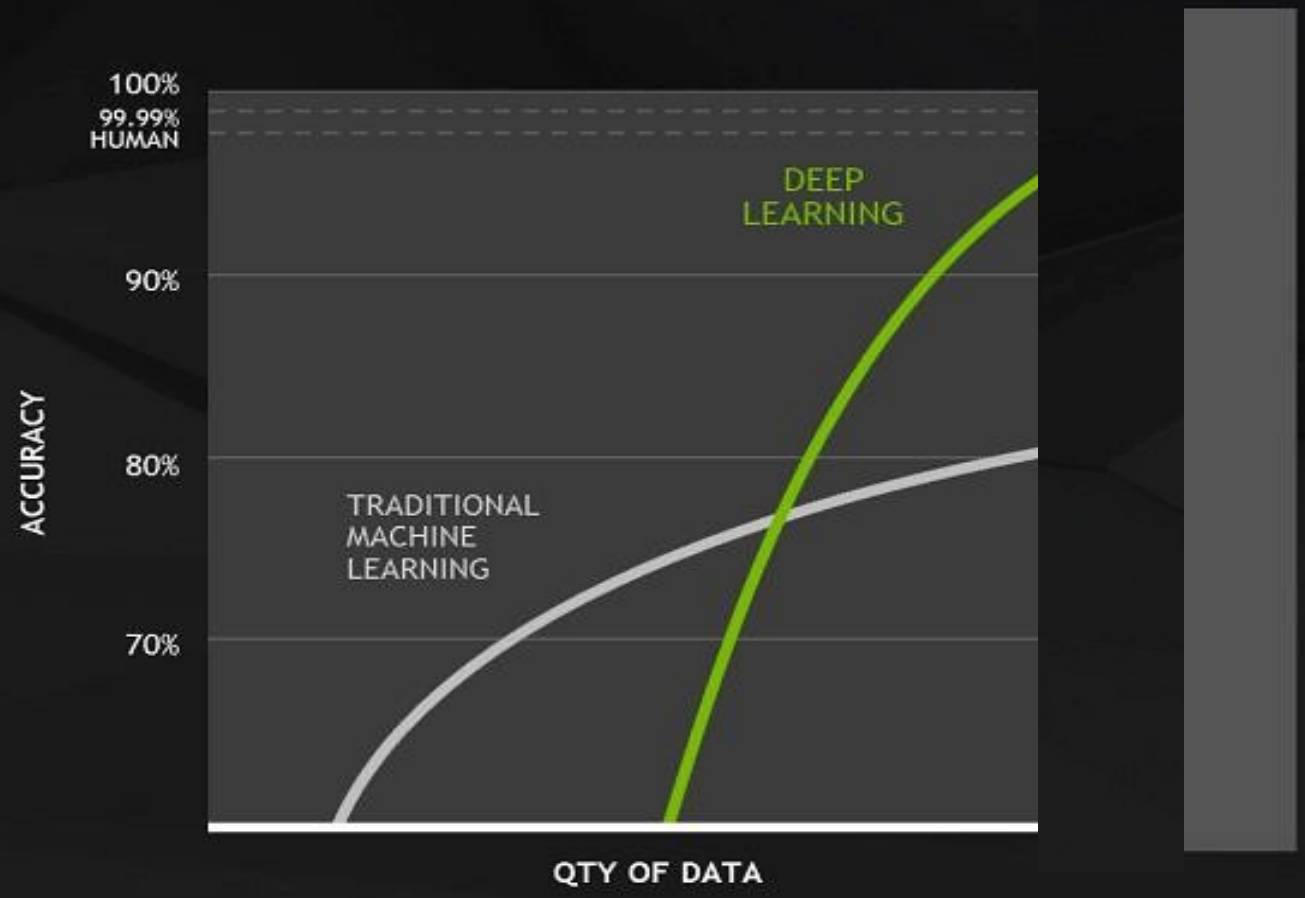
Data



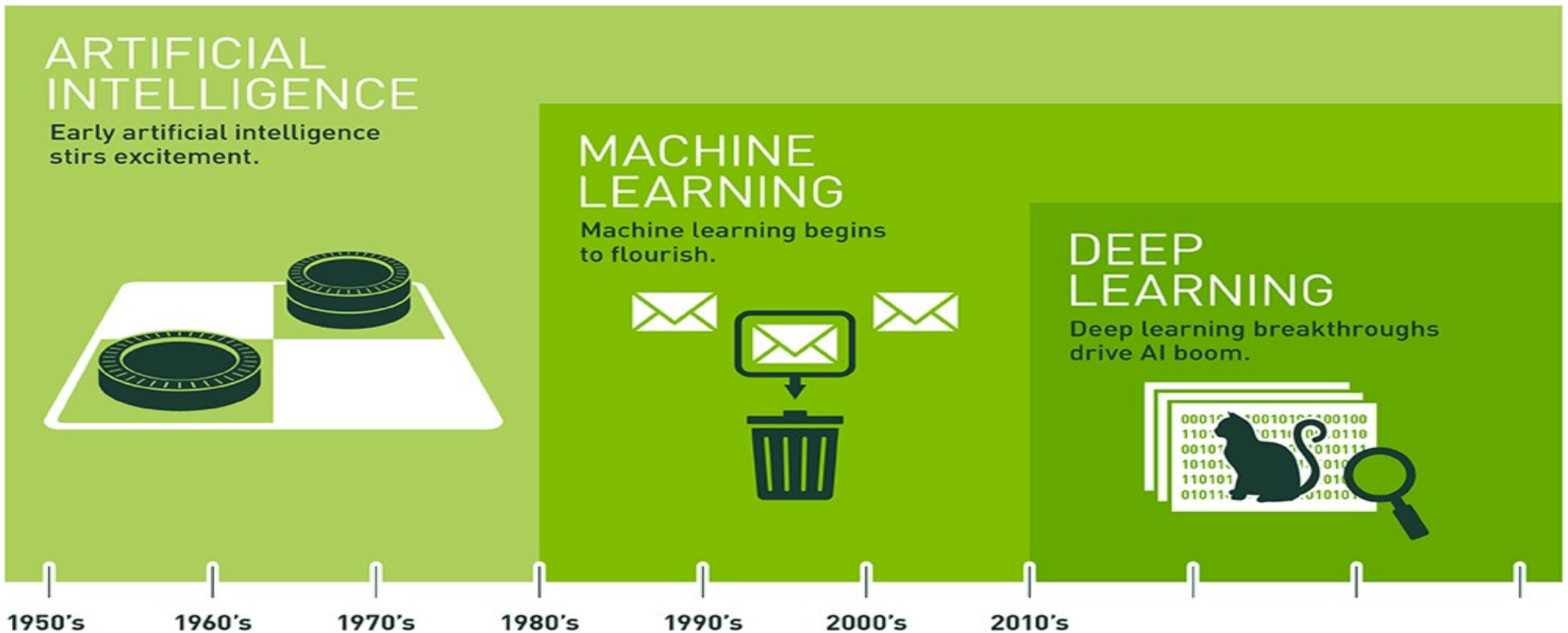
Algorithms

Compute

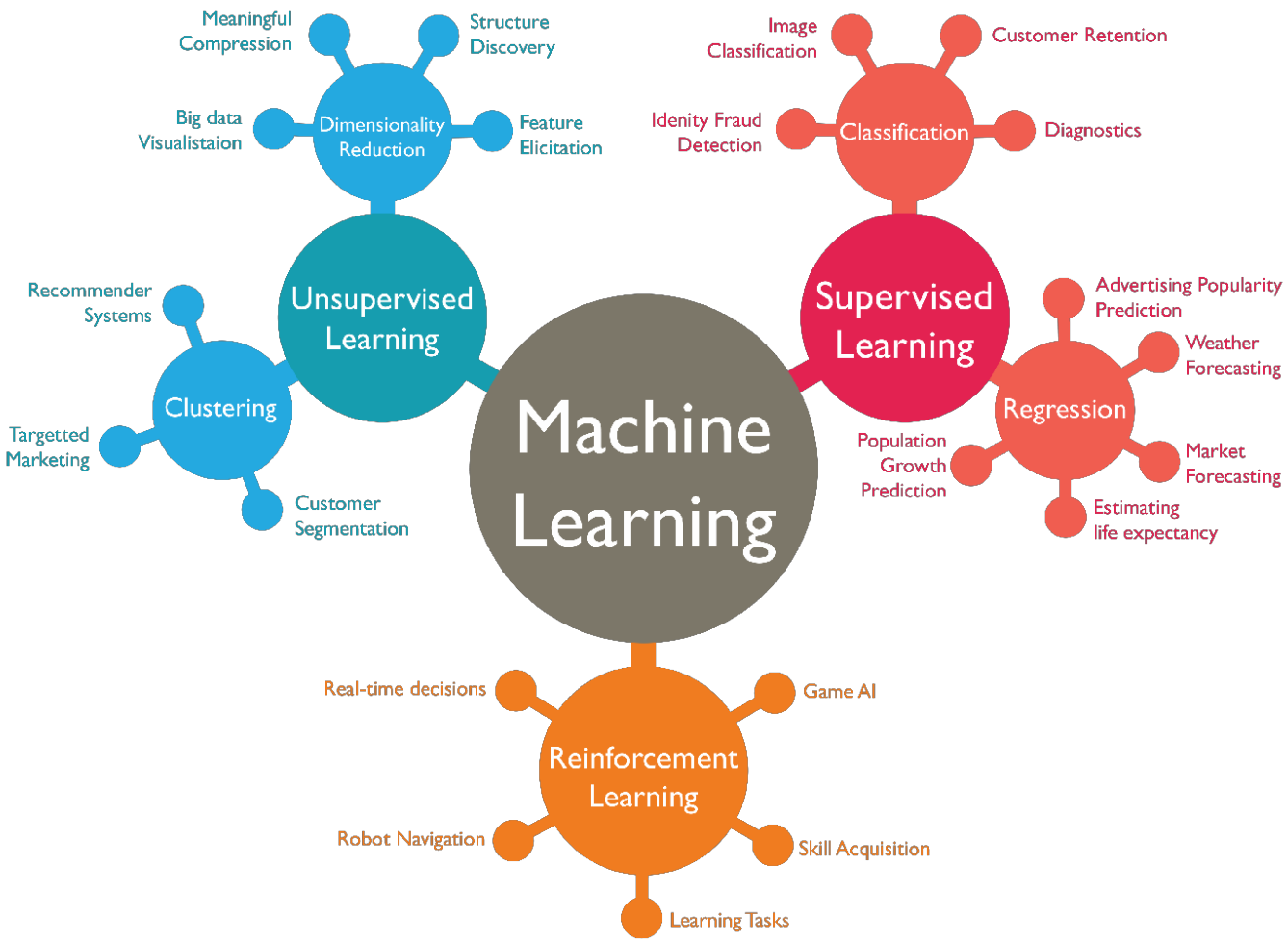
DEEP LEARNING WHEN ACCURACY MATTERS



AI AND DEEP LEARNING



TYPES OF ML/DL

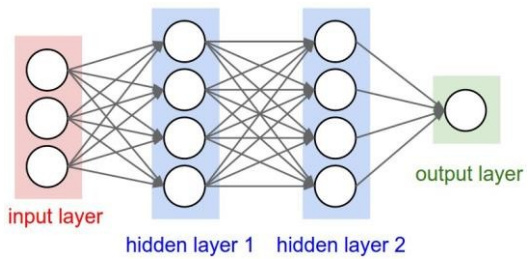


Deep Learning Categories

Main research areas and breakthroughs of DL

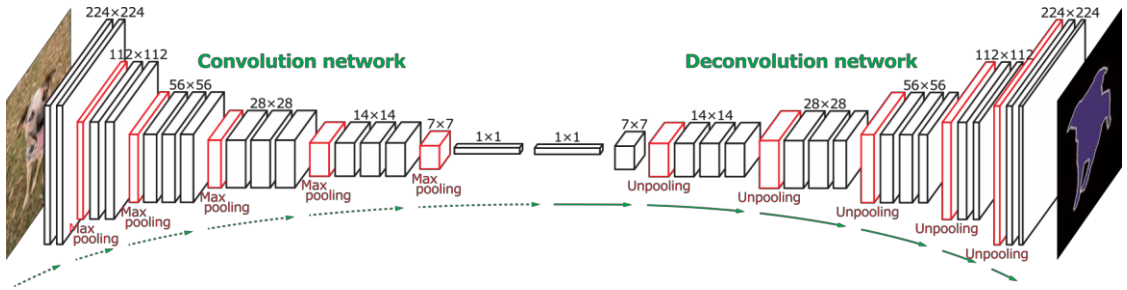
General Deep Learning

Fully-Connected (FC)



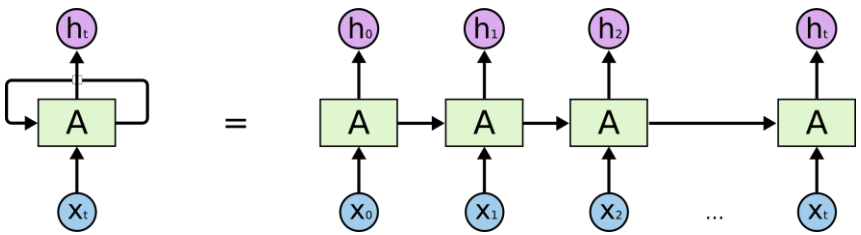
2D/3D Image model

CNN, FCN, etc.

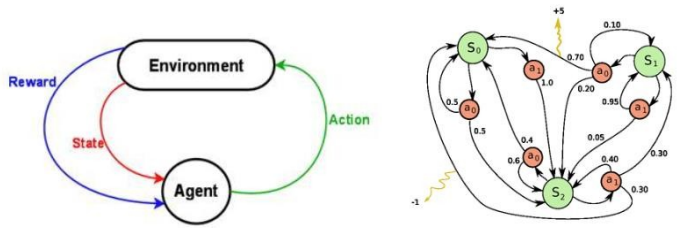


1D Sequence Model

RNN, LSTM, etc.

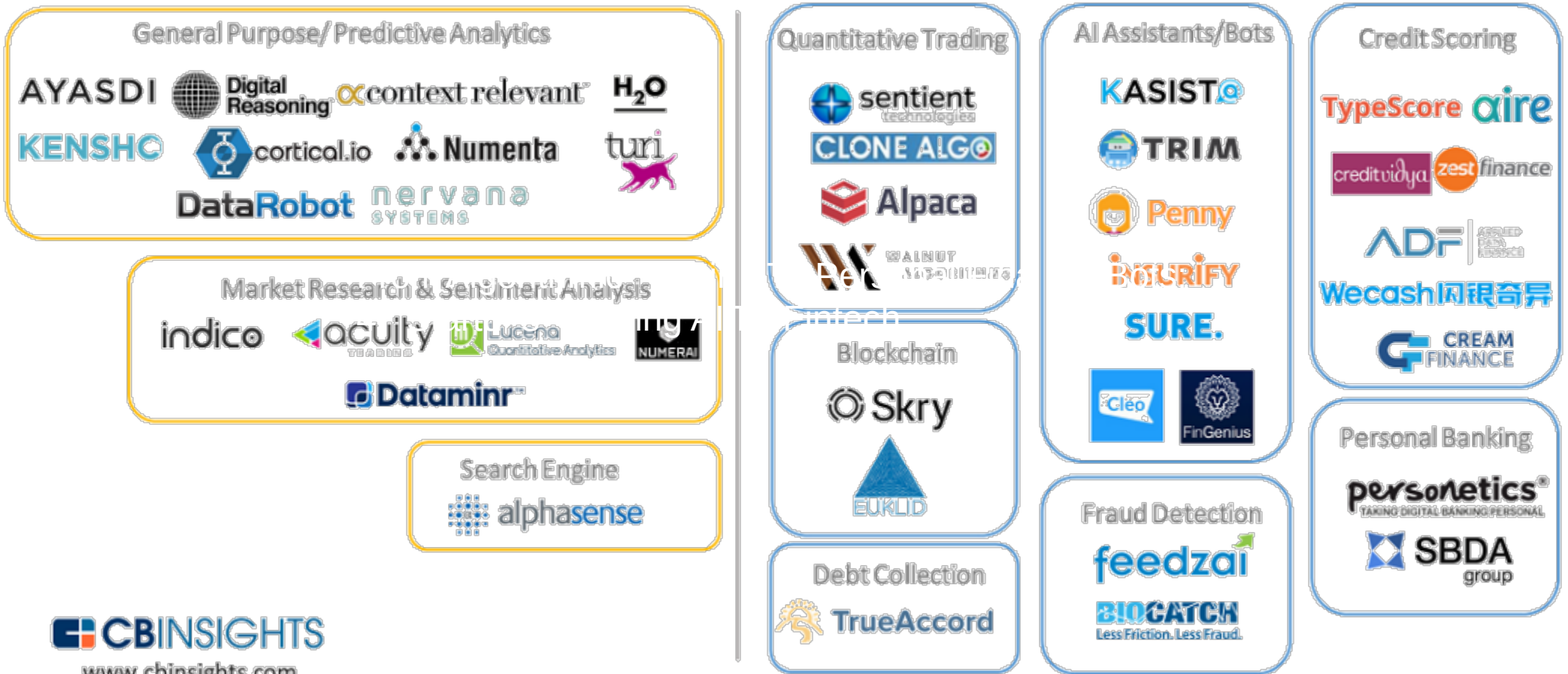


Others: unsupervised DL, reinforce Learning



A.I IN FINTECH

Algorithmic Trading, Chatbots, Fraud Detection and more…

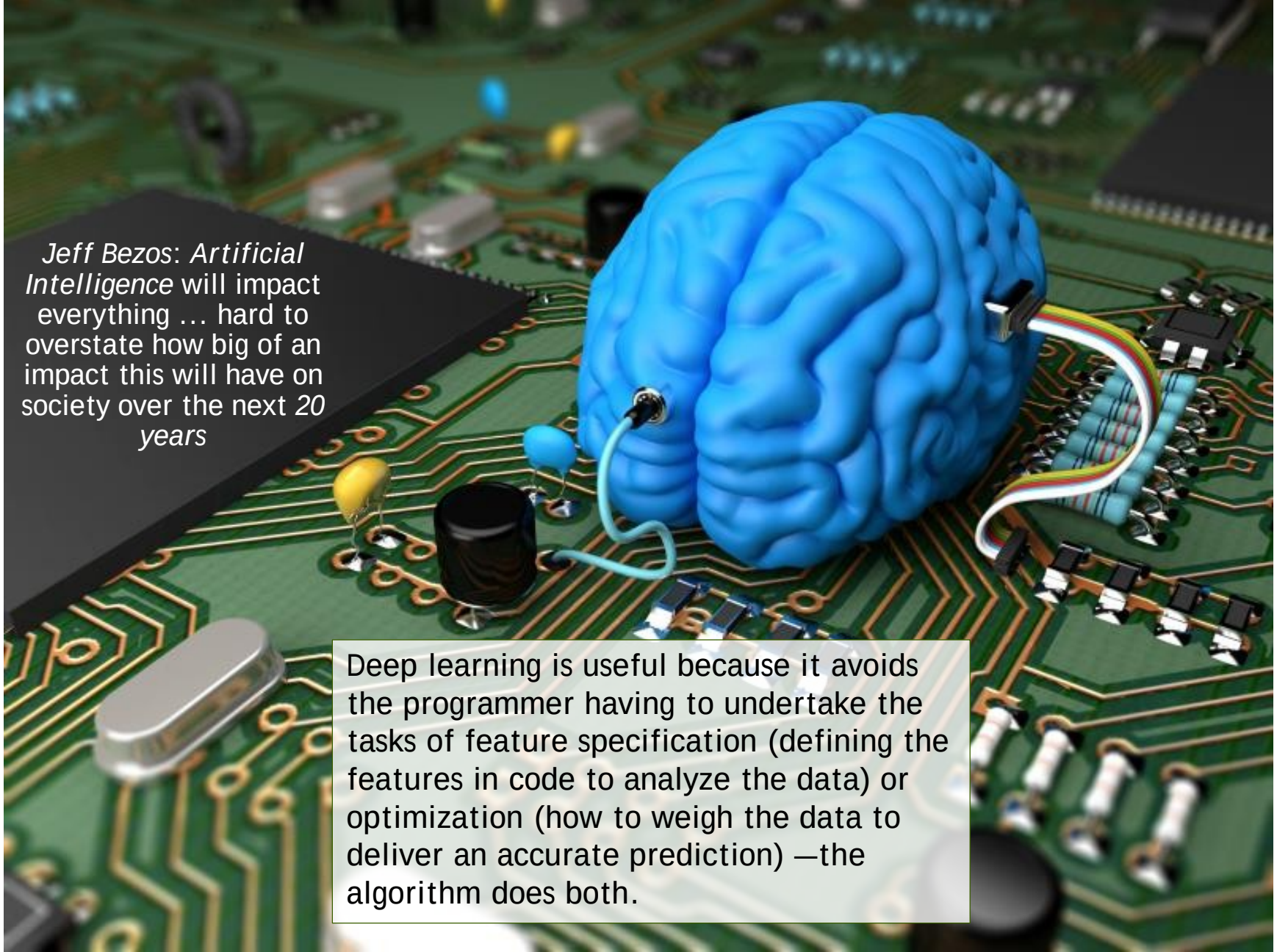


CBINSIGHTS
www.cbinsights.com

Source: https://www.cbinsights.com/blog/artificial-intelligence-fintech-market-map-company-list/

USE CASES – DEEP LEARNING

http://www.economist.com/news/finance-and-economics/21722685-fields-trading-credit-assessment-fraud-prevention-machine-learning


Jeff Bezos: *Artificial Intelligence* will impact everything … hard to overstate how big of an impact this will have on society over the next *20 years*
Deep learning is useful because it avoids the programmer having to undertake the tasks of feature specification (defining the features in code to analyze the data) or optimization (how to weigh the data to deliver an accurate prediction) —the algorithm does both.

E.

Deep Learning to predict how to get customers to pay their Credit Card bills

- What to do when Bank of Nova Scotia customers miss a credit card payment (Live Dec 2016)
- AI looks at patterns of behavior of millions of customers - payment history & interactions
- Recommends approach, email, phone call, collection agency etc.
- Tested against historical data & decision tree approach, AI created better results
- Moving now to car loans, mortgages, small-business loans, marketing recommendation engines

"The great thing about deep learning as a strategy and a technique is you don't have to have to figure it out all up-front. The data can actually tell you the right thing to do," Neil Bartlett, Scotiabank's SVP Analytics

https://blogs.wsj.com/cio/2017/02/06/scotiabank-deploys-deep-learning-to-improve-credit-card-collections/
http://www.globeinvestor.com/servlet/ArticleNews/print/GAM/20170203/RBSBSEREBRINSCOTIA

Deep Learning Trading Platform

- Google Tensorflow on GPU's allow us to solve problems in hrs that would have taken weeks two years ago.
- High Frequency and systematic trading has led to lots of data, this is the very data needed to train a Deep Learning (DL) Neural Network
- The traditional Quant approach does not spend much time discarding the noise
- DL is about learning the perfect representation of markets on which to make predictive models
- DL is much better than machine learning methods in social science, and trading is the ultimate human generated dataset

Approx. 70% of fund equities 15% Bonds, 10% Real Estate, 5% Cash

Performance comparison to Benchmark

	Sharpe	Q1 2016	Q2 2016	Q3 2016	Q4 2016	Q1 2017	Q2 2017	Total
qplum	**1.83**	**4.11%**	**4.88%**	**2.13%**	**0.16%**	**3.87%**	**0.94%**	**17.10%**
Blackrock Global Allocation Fund	1.55	3.00%	0.73%	3.84%	-0.04%	4.49%	1.88%	14.64%

Recording:

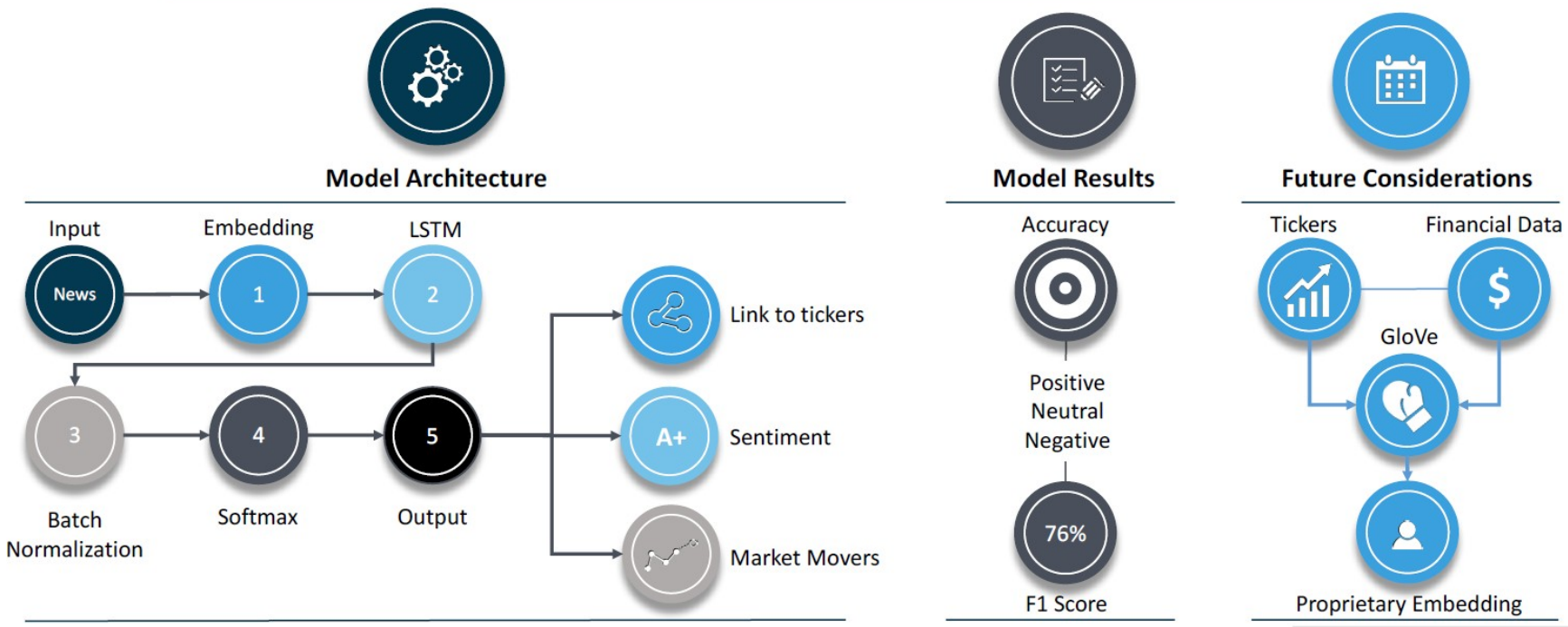
http://on-demand.gputechconf.com/gtc/2017/video/s7592-gaurav-chakravorty-ai-and-deep-learning-in-trading.mp4

PDF:

http://on-demand.gputechconf.com/gtc/2017/presentation/s7592-Gaurav-Chakravortya-DeepLearninginTrading.pdf

TRIUMPH
ASSET MANAGEMENT

Applying Deep Learning to Financial Markets with News Data



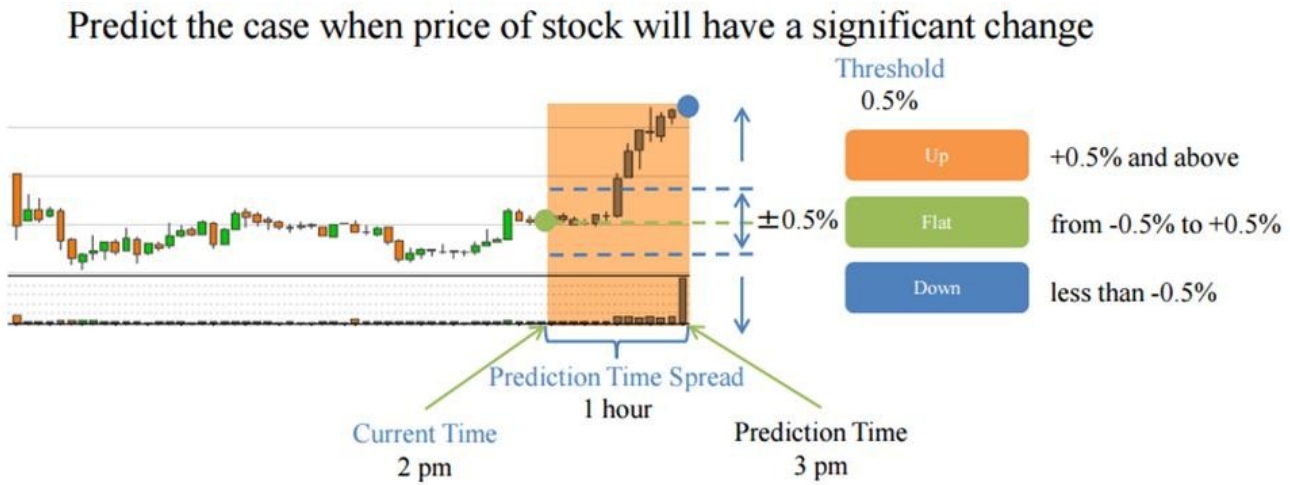
Recording:

http://on-demand.gputechconf.com/gtc/2017/video/s7696-andrew-tan-applying-deep-learning-to-financial-market-signal-identification-with-news-data.mp4

PDF:

http://on-demand.gputechconf.com/gtc/2017/presentation/s7696_Andrew-Tan_ FinancialMarketSignalIdentification.pdf

Performance Improvement of Algorithmic Trading Strategies Using Deep Learning



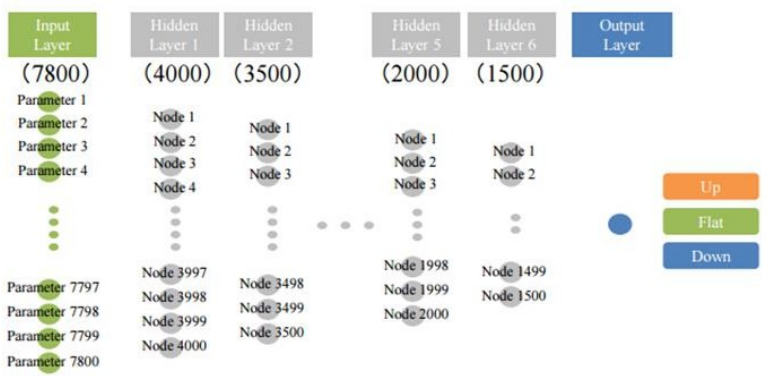
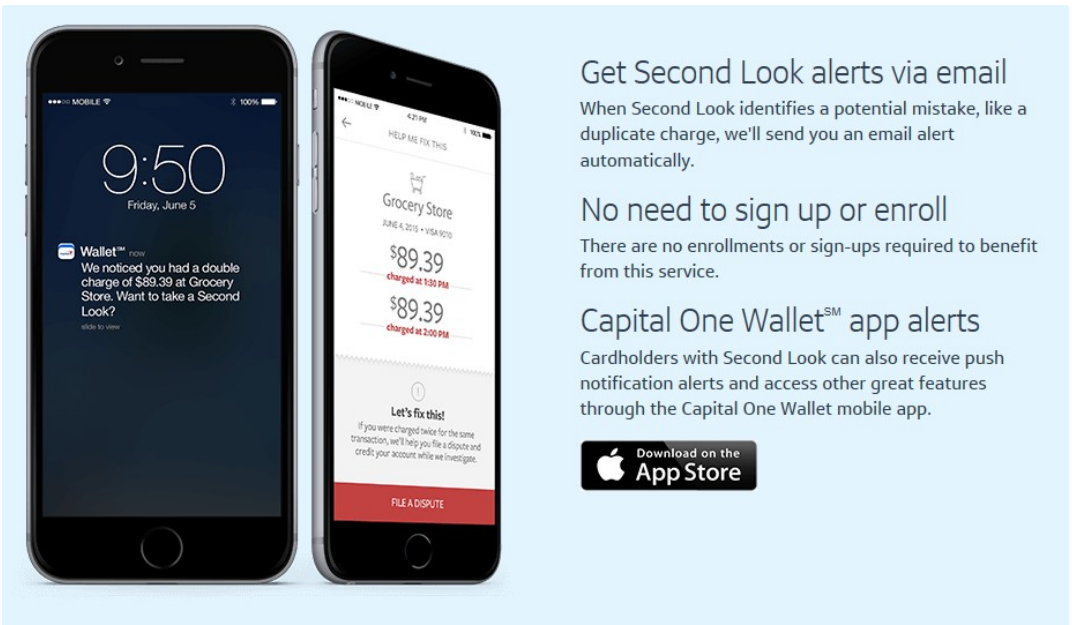


Fig 5. Structure of Deep Belief Network

http://on-demand.gputechconf.com/gtc/2016/presentation/s6589-masahiko-todoriki-performance-improvement-algorithmic-trading.pdf

Deep Learning for fraud detection and customer alerting

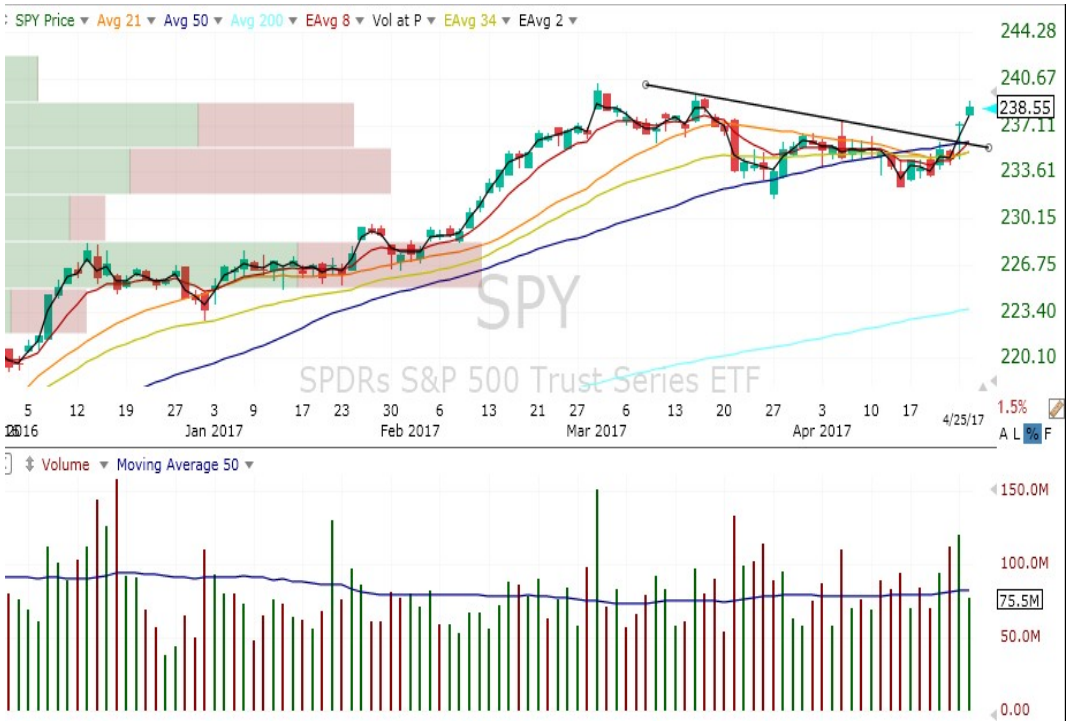


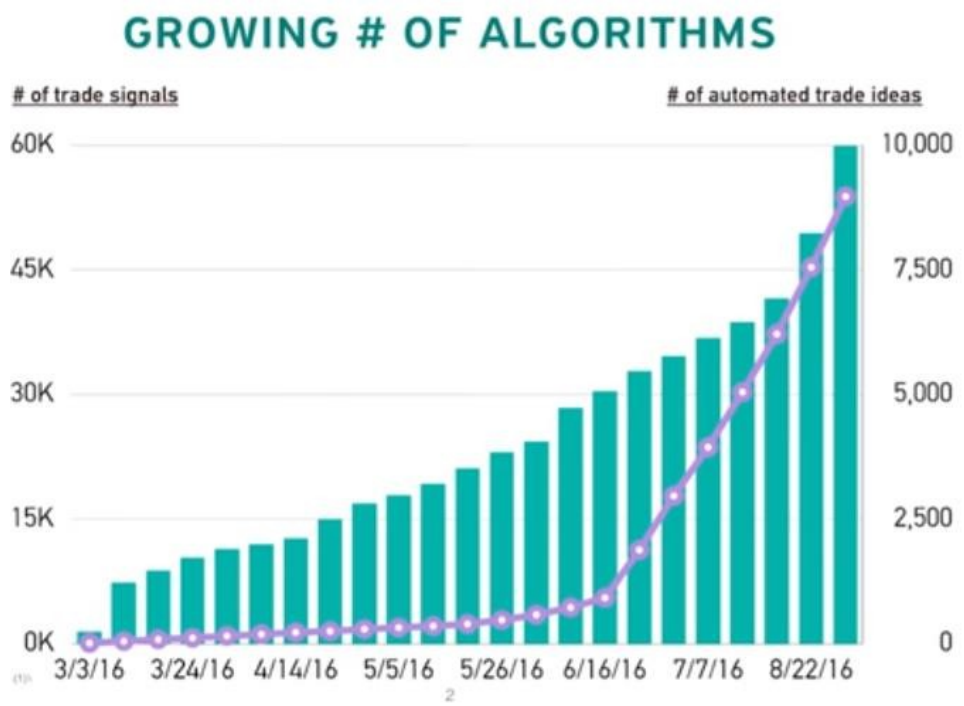
- In 2016, Capital One launched customer account access on Amazon's Alexa platform, allowing users to check their balances, pay their bills etc.
- March 2017 - AI - Natural language processing (NLP), an industry-first rollout of a NLP Chatbot named "ENO"
- Shifts the medium from voice to text - Ken Dodelin VP of digital product management "97% of smartphone users text, allows the Bank to interact in a format people find convenient"

https://venturebeat.com/2017/04/25/how-capital-one-transformed-into-a-tech-and-ai-company/

DEEP LEARNING CHART RECOGNITION

AlpacaAlgo





Fraud

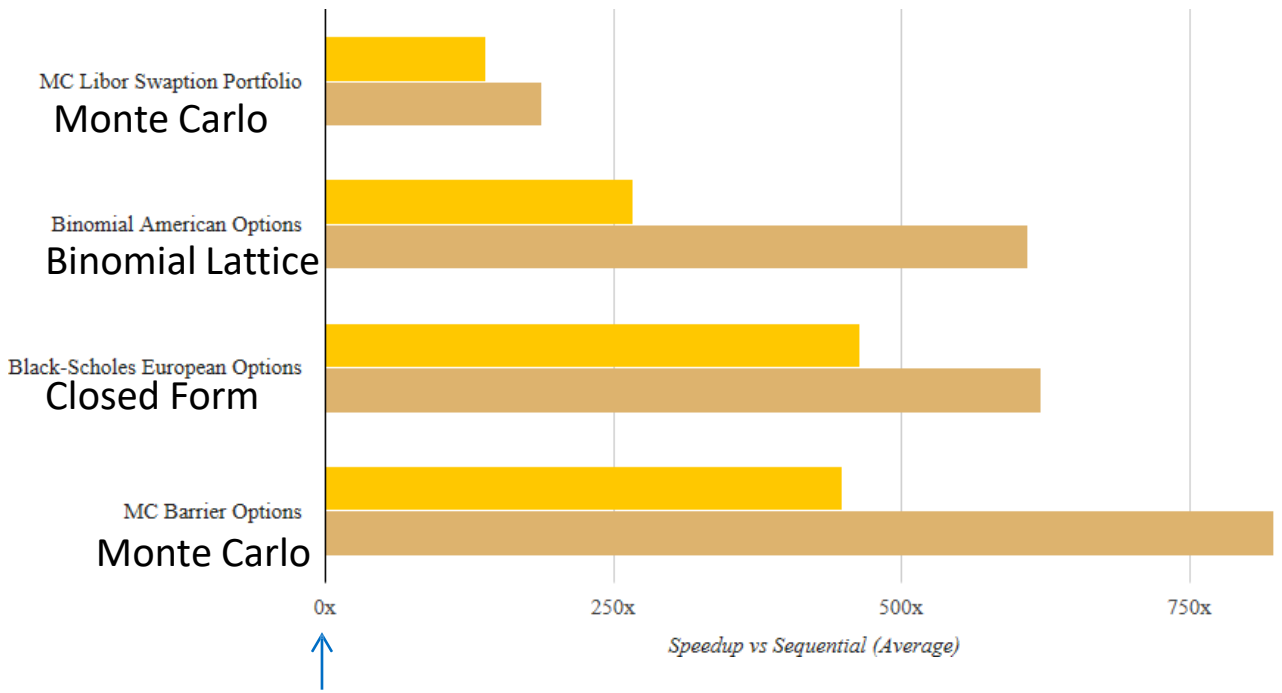
10,000s of features make up todays fraudulent behavior. AI can detect patterns faster and more accurate than humans

-Hui Wang, Senior Director of Global Risk Sciences, Pay Pal

xcelerit ®Computing Benchmarks

Benchmarks: Nvidia P100 vs K80 GPU

18th April 2017



JPMorganChase

SOCIETE GENERALE

HSBC

Bank of America

https://www.xcelerit.com/computing-benchmarks/insights/nvidia-p100-vs-k80-gpu/

THANK YOU!

USE CASES – MACHINE LEARNING

- Tesla™ GPUs are being used by the largest investment bank entity, J.P. Morgan Chase, to deliver a 40X increase in the end-to-end speed of its risk calculations, while reducing the cost of ownership by 75%

- Risk calculations now run in minutes not hours

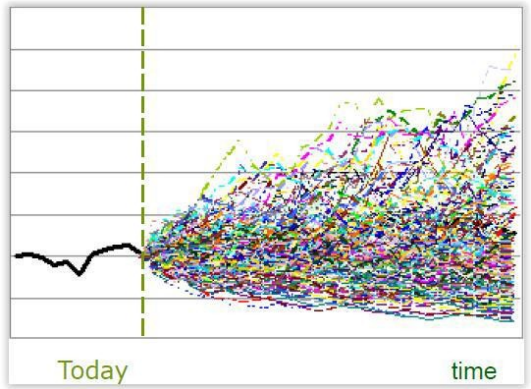
- This integration of GPUs into the shared global computational infrastructure has resulted in GPU utilization rates approaching 70 percent, 24 hours a day.

http://nvidianews.nvidia.com/news/nvidia-tesla-gpus-used-by-j-p-morgan-run-risk-calculations-in-minutes-not-hours

SOCIETE GENERALE

GPU IN PRODUCTION FOR INTRADAY RISK CALCULATIONS

For trader to produce option price to client they need speed and accuracy for 300,000 paths into the future



At Société Générale, GPU is now synonymous with performance and efficiency:

- 2013 : a client request for a very sophisticated product 5 min
- 2015 : same request 8 seconds
- GPU no longer reserved to a small expert community
  think parallel, not sequential.
- Every new algorithm should be thought in terms of parallel execution

http://on-demand.gputechconf.com/gtc/2015/presentation/S5666-Regis-Fricker.pdf

Counterparty risk exposure

Credit Value Adjustment (CVA) analysis must be carried out regularly over entire portfolio to compute risk exposure and consequently their regulatory capital requirements.

- Traditionally, this kind of calculation took many hours to run on a bank's grid facility, pressure to calculate intraday.
- "HSBCs competitive advantage lies in our extensive in-house code-base and libraries , important to harness the power of new hardware without having to maintain multiple versions of our code" Eurico Covas, Head of HSBC QRVG Development and Hedge Accounting Systems
- Less than handful of days effort, the developer was able to identify where the hot-spots were in the existing code and insert some carefully chosen lines invoking the GPU's
- The effects of the code transformation were dramatic. In one example, a set of 10,000 swap instruments was priced for a set of 1,000 Monte-Carlo scenarios at 26 time steps. This adds up to 260 million pricings in total. When using 1x GPU (older style K20) speed up of 19x compared to 1 CPU, 3 GPUs, this performance scales almost linearly, achieving a speedup of nearly 57x
- Used Xcelerit API approach allows small modifications to be made to an existing program or library and then the SDK takes care of mapping that code efficiently onto whatever combination of CPU or GPU hardware is available.
- GPU hardware executes these calculations much more efficiently with a performance-per-watt that is far superior to conventional computing approaches. This is a bonus for data centers constrained by space & and power.

https://www.xcelerit.com/hsbc-run-risk-in-eal-time-with-xcelerit-and-gpus/

- **“GPUs are big in banking:** The BofA uses GPU computing techniques often seen in online gaming and in high-performance scientific computing to run simulations in its derivatives business”

Brad Spiers, the senior vice president for Compute Innovation

https://gigaom.com/2012/05/01/bofa-tech-guru-preaches-6-cloud-truths/