TJIP

The fundamentals of Machine Learning

Introduction

Quick adaptation to change has never defined the finance industry. Although that remains true today, new technology advancements are changing every single aspect of our lives, including financial institutions.

Today's digitized economy is forcing the Chief Financial Officer to take on a much more strategic role, that involves capturing key financial and user data and analyzing it to generate financial projections and business growth. Not an easy task, by far.

Machine learning is combining **big data** and **predictive analytics** to reimagine consolidation, reporting, planning and forecasting – the foundational processes for understanding and driving business performance.

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1 The fundamentals
of machine learning

WHAT IS MACHINE LEARNING?

■ Machine learning is a subset of artificial intelligence that enables computers to learn without being explicitly programmed. Put simply, computers analyse new information and compare it with existing data to look for patterns, similarities and differences.

Each time it does this, the computer improves its ability to analyse, predict and classify information, allowing it to make increasingly better data-driven decisions. The process plays a significant role in areas as diverse as spam filtering, facial recognition, weather predictions and medical diagnosis.

Fintech services already use machine learning to prevent fraud by flagging unusual transactions and odd spending patterns, and it is far more efficient than manual monitoring. Thus, the smart application of machine learning principles in the field of customer service can ensure fintech stays competitive in the financial space.

Why do we need machine learning?
Machines that learn are useful to humans because, with all of their processing power, they're able to more quickly highlight or find patterns in data that would have otherwise

been missed by human beings. Machine learning is a tool that can be used to enhance humans' abilities to solve problems and make informed inferences on a wide range of problems, from helping diagnose diseases to coming up with solutions for global climate change.

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"Machine Learning is the science of getting computers to learn and act like humans do, and improve their learning over time in autonomous fashion, by feeding them data and information in the form of observations and real-world interactions."

- HTTP://TECHEMERGENCE.COM/WHAT-IS-MACHINE-LEARNING/

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The growth of the internet and the coming of the digital age has made available large volumes of data - big data. But this overwhelming amount of data is fuelling demand for techniques to filter out useful information from the irrelevant within these massive data sets. This is where machine learning plays a crucial role.

A big part of machine learning is the ability for machines to discover relationships and associations within data sets that might

> Fintech services already use machine learning to prevent fraud by flagging unusual transactions.

have been previously obscured or not even conceived of by human researchers (what is known as "unsupervised learning").

THE BASIC CONCEPTS OF MACHINE LEARNING

Machine learning is the process by which a machine learns new ways of processing and analyzing data by comparing new information to new information, without being programmed to do so. The process of machine learning has three main steps:

- Input
- Abstraction
- Generalization

Input
The computer received data in the form of databases, text files, or spreadsheets. Machines learn best when they have higher levels of variety, density, and volume of data. Data quality is important so before the data is input, people need to make sure that issues such as missing fields and outliers are resolved.

Abstraction
The systems analyzes the data through a set of algorithms. People need to make sure they start with an appropriate algorithm in order to receive accurate results and efficient learning.

Generalization
The computer changes the algorithm in response to the data and analysis. As the computer delivers results and learns on its own, people need to evaluate the algorithms used and make changes when necessary in order to create an effective system.
The steps described on the previous page are common across all types of machine learning. Most machine learning takes one of three forms:

- Supervised
- Unsupervised
- Reinforcement

Supervised Learning
This type of machine learning using predictive models that help predict the future based on historical data. They are called supervised basically because programmers tells them what to learn and how to learn it.

Unsupervised Learning
This type of learning trains descriptive models to predict and describe a result from a set of neutral or untargeted data requests. For example, a user may want a computer program to predict the outcome of an event with certain criteria. There is no set result and all the criteria are equally important.

> All combinations of machine learning algorithms, regardless of learning styles, consist of representation, evaluation and optimization.

Reinforcement Learning

Using reinforcement learning, the machine makes specific choices based on certain requirements. The machine will continuously train itself based on what it has been exposed to and then use this new training to improve decision making skills.

there are several different types of machine learning algorithms. They're generally grouped by either learning style (i.e. supervised learning, unsupervised learning, semi-supervised learning) or by similarity in form or function (i.e. classification, regression, decision tree, clustering, deep learning, etc.). All combinations of machine learning algorithms, regardless of learning styles, consist of:

- Representation (a set of classifiers or the language that a computer understands)

- Evaluation (aka objective/scoring function)

- Optimization (search method; often the highest-scoring classifier, for example; there are both off-the-shelf and custom optimization methods used)

The ultimate goal for machine learning algorithms is to have them generalize beyond the samples they've been trained with, in order to successfully interpret new data.

2 Applications of machine learning in finance

MACHINE LEARNING AND SECURE FINANCIAL TRANSACTIONS

MANAGING FINANCIAL RISK WITH MACHINE LEARNING

FRAUD PREVENTION THROUGH ALGORITHMS

MACHINE LEARNING HELPS ROBOTIZE INVESTMENTS

HOW MACHINE LEARNING IMPROVES CUSTOMER SERVICE

■ The finance industry has traditionally been relying on historically-driven forecasting and regressive models. These legacy approaches have been falling short in today's digital economy, to the point where they no longer reflect the reality of the business.

Moreover, in most companies, highly qualified finance professionals spend more than half their time combining through and compiling data from a variety of spreadsheets, notes and internal systems. The majority of their time and energy is spent on checking, cleansing, and reusing old data with very little time to correlate it against outside factors or information from external sources.

Machine learning has the ability to compile and interpret unimaginable volumes of operational and transactional data, making it possible for financial institutions to access present and future predictions rather than relying on mountains of historical data.

From assessing credit risks to increasing network security, fintech startups, in particular, are turning to finance-based machine learning solutions in order to work smarter rather than harder.

With the ability of machine learning applications to catch costly errors, to improve efficiency, to augment decision-making processes, and to improve the customer experience, machine learning offers benefits on the front end, the back end, and everywhere in between.

It's important to mention that the costs involved with machine learning adoption are not small, in terms of both software and hardware. However, as with any good investment, the payoff far outways the initial expense, as costs are reduced and profits are realized over time.

Let's look at some of the existing applications of machine learning in the financial industry:

CASE I
MACHINE LEARNING AND SECURE FINANCIAL TRANSACTIONS

Banking and financial institutions need to secure the storage, transit and use of corporate and personal data across business applications, including online banking and electronic communications of sensitive information and documents.

> Machine learning has the ability to compile and interpret unimaginable volumes of operational and transactional data

[The power of intelligent pattern analysis](#), combined with big data capabilities, certainly gives machine learning technology an edge over traditional, non-AI tools. One might go so far as to declare machine learning as the last hope of securing critical networks against professional and state-sponsored cyber attacks.
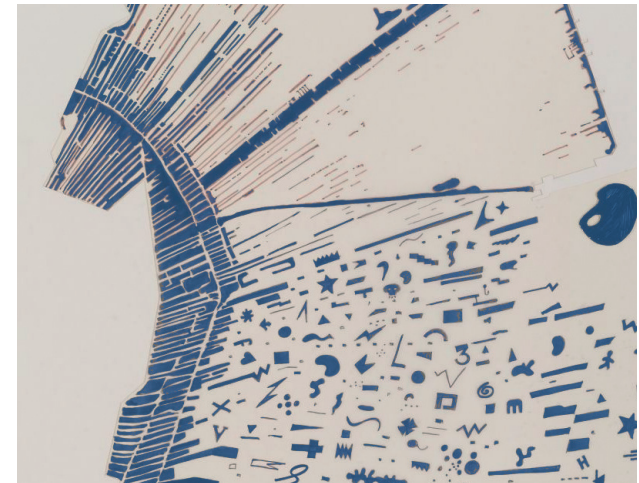
[Big data](#) can enhance data security for the finance industry through various means:

- Understanding activity patterns among customers and the broader industry.

- Sharing of data – critical especially for emerging attack vectors and threats.

- Increasing reliance on data to predict attacks, based on trends that are targeting the industry.

Usernames, passwords, and security questions [may no longer be the norm](#) for user security in five years. In addition to anomaly-detection applications like those currently being developed and used in fraud, future security measures might require facial recognition, voice recognition, or other biometric data.

[Malware](#) remains a huge problem for financial institutions. In 2014, [Kaspersky Lab](#) said it had detected 325,000 new malware files every day. But, institutional intelligence company Deep Instinct says that each piece of new malware tends to have almost the same code as previous versions — only between 2 and 10% of the files change from iteration to iteration. Their learning model has no problem with the 2–10% variations, and can predict which files are malware with great accuracy. In other situations, machine learning algorithms can look for patterns in how data in the cloud is accessed, and report anomalies that could predict security breaches.

[Confirming](#) that machine learning is a viable network security tool, [Microsoft](#) is investing heavily in its own "deterministic" machine learning/big data platform. Using statistical analysis of baseline metrics, along with historical data from "bad" behaviors,

Machine learning algorithms can look for patterns and report anomalies.

computer scientists are constructing models that can identify "anomalous" or abnormal behaviors. Even though not every organization replicates the resources of Microsoft, the lessons learned from the tech giant will help fuel independant development in the fintech/financial IT security space.

CASE II
MANAGING FINANCIAL RISK WITH MACHINE LEARNING

The ability to leverage crucial insights from huge datasets enables businesses to predict consumer behaviour, set strategic goals, identify and manage risks, and much more.

A 2015 report from McKinsey & Company identified a dozen European banks that made the shift from traditional statistical analysis modelling to machine learning. The results of the report are impressive, with some organisations increasing new product sales by ten percent, while churn and capital expenditures have both declined by 20 percent.

While traditional software applications predict credit-worthiness based on static information from loan applications and financial reports, machine learning

technology can also analyze the applicant's financial status as it may be modified by current market trends and even relevant news items. Micro-targeted models that can predict the consumers most likely to cancel services or default on credit are among the common applications of these new systems. These early warning capabilities ensure that banks can intervene before problems escalate.

Moreover, by applying predictive analysis to huge amounts of data in real time, machine learning technology can detect rogue investors working in unison across multiple accounts — something that would be nearly impossible for a human investment manager.

"Banks are experimenting with self-learning algorithms in credit underwriting, monitoring, and credit-card fraud detection, with encouraging results. (...)

Advances in behavioral economics will also help risk managers make better choices as they learn to recognise and eliminate common biases from their decisions."

- MCKINSEY

CASE III
FRAUD PREVENTION THROUGH ALGORITHMS

Financial service providers have a responsibility to protect their clients against fraudulent activity. Financial fraud costs Americans, alone, $50 billion annually.

Machine learning is getting better and better at spotting potential cases of fraud across many different fields. By comparing each transaction against account history, the algorithms are able to assess the likelihood of transactions being fraudulent.

Conspicuous activities, such as out-of-state purchases or large cash withdrawals, alert the system and cause it to introduce steps to delay the transaction until a human can make a decision. Depending on the nature of the attempted transaction, a purchase or withdrawal attempt may be automatically declined.

The algorithm is able to quickly weigh the transaction details against thousands of data points and make a determination whether or not the attempted activity is uncharacteristic of the account owner, an activity that a human cannot perform. Furthermore, the algorithms adjust themselves in response to changing habits on the part of the account owner.

PayPal, for example, is using machine learning to fight money laundering. The company has tools that compare millions of transactions and can accurately distinguish between legitimate and fraudulent transactions. Amazon, Microsoft, IBM, and Google are each integrating machine learning capabilities into their cloud-based developer interfaces.

CASE IV
MACHINE LEARNING HELP ROBOTIZE INVESTMENTS

Portfolio Management
Robo-advisors are algorithms built to calibrate a financial portfolio to the goals and risk tolerance of users. Users enter their goals (for example, retiring at age 65 with $250,000.00 in savings), age, income, and current financial assets. The advisor or allocator then spreads investments across asset classes and financial instruments in order to reach the user's goals. The system will proceed to calibrate to changes in the user's goals and to real-time changes in the market, to identify the best fit for the user's original goals.

> Robo-advisors have proven quite popular among millennial consumers who don't need a physical advisor.

Robo-advisors have proven quite popular among millennial consumers who don't need a physical advisor to feel comfortable investing, and who are less able to validate the fees paid to human advisors.

Financial Predictions
Financial prediction is one of the hardest tasks in machine learning.
Computer aided trading services allow investors to have an order placed when a stock reaches a predetermined price, and to sell when that price drops below a certain limit. By automating functions, this type of platform makes trading easier for large and small investors, alike. While they can even make recommendations based on automated analysis of market trends, they have limitations.

Over the past few years, hedge funds have increasingly moved away from traditional predictive analysis methods and have adopted machine learning algorithms for predicting fund trends. Using machine learning, fund managers hope to identify market changes earlier than when they can with traditional investment models.

EOTPRO Developments' platform DeepStreet EDGE runs proprietary algorithms that can predict intraday stock price movement before

a piece of news is priced into the stock. The system accesses 43 news feeds before the web gets the news. Then they aggregate all those predictions and predict the direction of the 4 US indices and warn when not to trade, when reversal is about to hit and the possibility of a retracement. The more the machine learns about its success rates from past predictions on a specific stock, the better its accuracy.
Major financial institutions like JPMorgan, Bank of America, and Morgan Stanley are developing automated investment advisors, powered by machine learning technology. Other companies like Two Sigma Investments, D. E. Shaw, Renaissance Technologies, and Hudson River Trading are consistently successful in automated trading strategies, generating very high returns for their clients / themselves.

Many trading firms have started to use proprietary systems to predict and execute trades at high speeds and high volume. These systems rely on probabilities, consuming vast quantities of data.
Algorithmic trading, also referred to as "Automated Trading Systems," involves the use of complex AI systems to make extremely fast trading decisions. Algorithmic systems often making thousands or millions of trades in a day, hence the term "high-frequency

trading" (HFT), which is considered to be a subset of algorithmic trading.

CASE V
HOW MACHINE LEARNING IMPROVES CUSTOMER SERVICE

Empowered buyers are demanding a new level of customer experience. With the universal utilization of automated phone support, many of them are frustrated by not being able to speak to a human. In addition, companies that focus on customer experience outperformed the overall S&P market by 27% and outperformed companies that are lagging in customer experience by 81%. This presents a unique opportunity for innovative financial service companies who want to explore machine learning.

A common complaint in banking is that low-value customers don't get the same level of customer service as high-value customers do. Machine learning is believed to be the missing piece of the puzzle, providing a human touch to a highly digitized customer service system that offers higher satisfaction.

Fintech firms like Kasisto use machine learning algorithms that are applied to the company's online Q&A offering - the 'live' chat rooms where customer service representatives answer questions in real

time. This enables a 'human-like chat experience' where machine learning assists in responding to queries and helps lower the number of actual human representatives needed to run the platform, meaning resources can be allocated elsewhere. The software also analyses the information coming in and uses it to improve its ability to offer a more targeted, streamlined and specialised offering to the customer in the future - something that would require unfeasibly large amounts of staff for a traditional bank.

Wallet.AI is another firm experimenting with personalized customer service. Their 'personal finance service' uses a person's financial profile and transaction records to help advise them on day-to-day spending. It may warn a user to reconsider spending money on a cab when other cheaper transport options are available nearby or warn that purchasing those new shoes will make it impossible to pay for rent at the end of the month.

Conversational interfaces
With the rise of platforms like Siri, Google Now, Cortana, and Amazon Echo, chatbots and conversational interfaces are a rapidly expanding area of venture investment and customer service budgets.

Empowered buyers are demanding a new level of customer experience.

Companies like Kasisto are already building finance-specific chat bots to help customers ask questions via chat such as "How much did I spend on groceries last month?" and "What was the balance of my personal savings account 60 days ago?" These

assistants have had to be built with robust natural language processing engines as well as reams of finance-specific customer interactions.

But while companies are constantly pushing for deeper levels of engagement with their customers, customers don't always want it. It remains to be seen how customer service conversational interfaces will achieve a balance between the wants and needs of customers and the service of the company.

"We are moving from us having to learn how to interact with computers to computers learning how to interact with us."

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3 **What's next** for machine learning in finance?

■ Today, approximately 50% of financial staff are dedicated to risk-related operational processes such as credit administration, while 15 percent work in analytics. McKinsey research suggests that by 2025, these numbers will be closer to 25 and 40 percent, respectively.

Gartner identified machine learning as a top ten strategic technology trend in 2016, advising businesses to find ways to actively leverage machine learning if they want to gain a competitive advantage.

A similar recommendation comes from McKinsey, warning financial organisations to digitise their core processes between now and 2025. By that time, most companies should have minimised their manual interventions, with modelling, automation and standardisation becoming firmly entrenched, if they want to remain competitive in their markets.
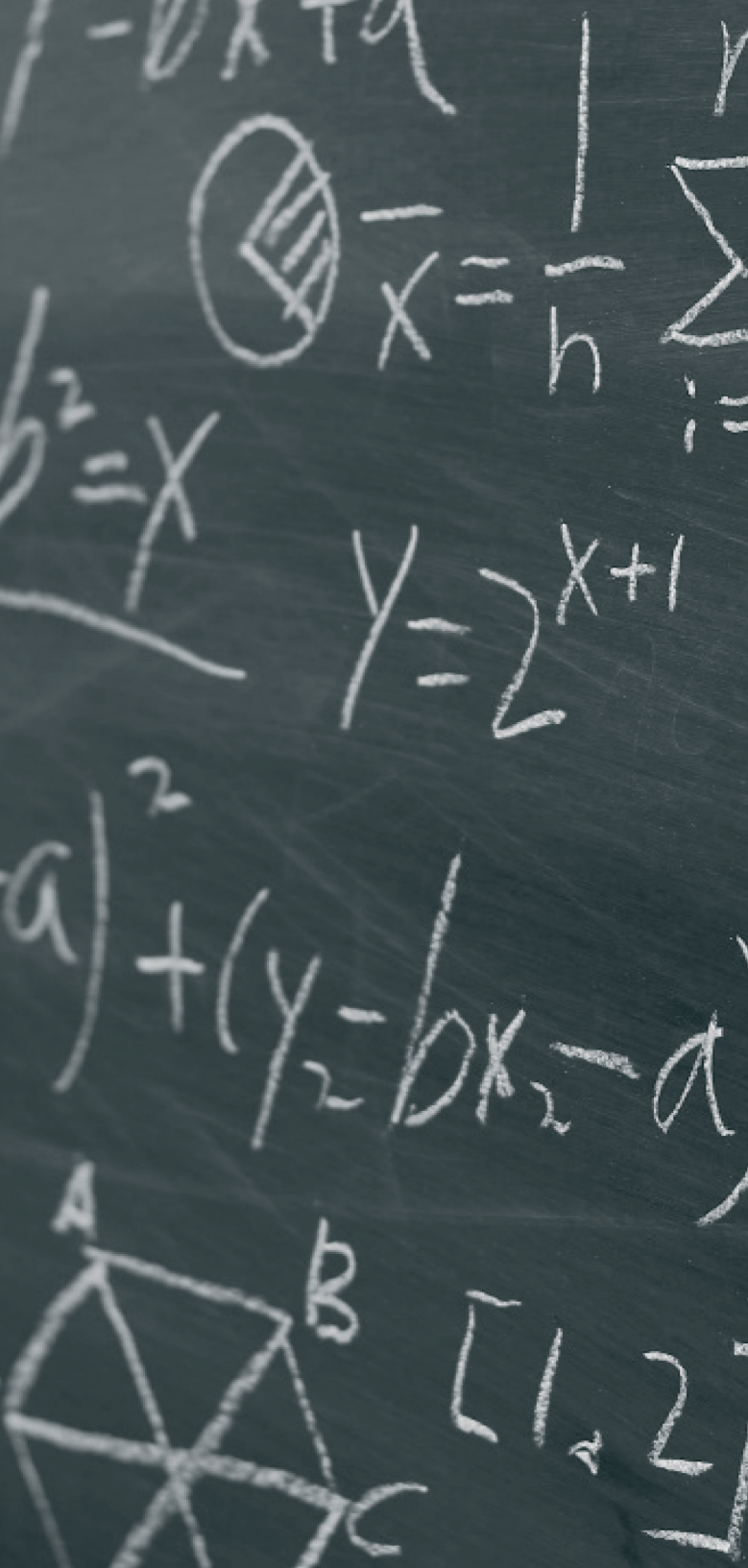
Juniper Research shows that Fintech platform revenues for unsecured consumer loans issued using machine learning technology are set to see a jump of 960% during the period 2016-2021, rising to $17 billion globally in the latter forecast year. This rise is driven by advances in analytics and accessible computing power.

"Risk functions should experiment more with analytics, and particularly machine learning, to enhance the accuracy of their predictive models. (...) Some financial institutions have already achieved significant model improvements, leading to better credit-risk decisions."

- MCKINSEY

The new study, AI & Machine Learning: Fintech Dynamics, Disruption & Future Opportunities 2016-2021 found that machine learning expenditures in Fintech will advance rapidly, owing to the highly data-driven nature of the market, meaning that AI integration is likely to spell substantial benefits.

Machine learning expenditures in Fintech will advance rapidly.

Conclusion

The future may already be here.

The future may already be here, with DeepMind's recent breakthrough, the Differential Neural Computer (DNC). It relies upon a high throughput external memory device to store previously learned models, combined with a system for generating new neural networks based upon the archived models. For the first time, a neural network has the ability to generalize learning.

While it's too soon to tell how machine learning and artificial intelligence will evolve, it's fair to project exponential changes in the financial industry. With generalized learning capabilities, these systems can offer new solutions to old and new problems alike, making our role a completely strategic one.

Although the financial industry has been slow to change or even a bit resistant to adapt, changes in consumer behavior, technology, and other industries have forced the financial industry to readjust. The traditional institutions in the financial industry have had to change or lose their market share to fintech.

The current state of machine learning is just a precursor to how AI and machine learning will continue to shape the financial industry in the years to come.

ABOUT TJIP

Our team of over 80 thinkers and doers of diligent consultants, software architects, developers, analysts, project managers and test coordinators creates quality software for different organizations, mostly in the financial and banking industry.

We specialize in the development of front-office software, and we're committed to working with our clients to optimize their business processes. We pride ourselves in delivering on time and on budget, since 1999.

Curious how we can optimize the processes of your organization? Contact us on www.tjip.com

References

- http://techemergence.com/what-is-machine-learning/
- https://www.linkedin.com/pulse/machine-learning-finance-25-years-robert-hillman
- http://homes.cs.washington.edu/~pedrod/papers/cacm12.pdf
- http://tidemark.com/blog/the-shift-for-finance-towards-machine-learning
- http://insidebigdata.com/2014/10/20/big-data-finance-security-regulatory-compliance-considerations/
- http://igniteoutsourcing.com/publications/machine-learning-in-finance/
- http://blog.strands.com/machine-learning-in-finance-present-future-ai-applications
- http://www.forbes.com/sites/bernardmarr/2016/09/30/what-are-the-top-10-use-cases-for-machine-learning-and-ai/#75b6f13310cf
- http://www.kaspersky.com/about/news/virus/2014/Kaspersky-Lab-is-Detecting-325000-New-Malicious-Files-Every-Day
- https://msdn.microsoft.com/en-us/library/mt422593.aspx
- http://www.barclaysimpson.com/news/machine-learning-the-next-frontier-for-financial-risk-management--news-801817925
- http://www.mckinsey.com/industries/high-tech/our-insights/an-executives-guide-to-machine-learning
- http://knowledge.insead.edu/blog/insead-blog/machine-learning-for-risk-management-4837
- http://www.mckinsey.com/business-functions/risk/our-insights/the-future-of-bank-risk-management
- http://www.bbb.org/detroit/news-events/other-news/2015/05/non-traditional-costs-of-financial-fraud/
- http://gizmodo.com/how-banks-use-machine-learning-to-know-a-crooks-using-y-1744771152
- http://www.informationweek.com/strategic-cio/executive-insights-and-innovation/11-cool-ways-to-use-machine-learning/d/d-id/1323375?image_number=5
- http://www.infoworld.com/article/2907877/machine-learning/how-paypal-reduces-fraud-with-machine-learning.html
- http://techemergence.com/machine-learning-in-finance-applications/
- http://www.wired.com/2016/01/the-rise-of-the-artificially-intelligent-hedge-fund/
- https://www.quora.com/Can-machine-learning-predict-stock-prices
- http://www.bloomberg.com/news/articles/2016-06-08/wall-street-has-hit-peak-human-and-an-algorithm-wants-your-job
- http://www.verndale.com/insights/blog/2015/april/3-areas-to-focus-for-a-contextual-customer-experience/
- http://www.huffingtonpost.com/doug-a-sandler/where-have-all-the-humans_b_9408562.html
- http://blog.onfido.com/machine-learning-makes-banking-more-personal/
- https://www.linkedin.com/pulse/chatbots-conversational-interfaces-rise-messaging-sean-johnson
- http://www.gartner.com/newsroom/id/3143521
- http://www.barclaysimpson.com/news/machine-learning-the-next-frontier-for-financial-risk-management--news-801817925
- https://www.juniperresearch.com/press/press-releases/fintech-ai-revenue-to-grow-960-by-2021-driven-by
- https://www.extremetech.com/extreme/238073-in-historic-moment-for-ai-computers-gain-ability-to-generalize-learning-between-activities