#MACHINE INTELLIGENCE & AUGMENTED FINANCE

How Artificial Intelligence creates $1 trillion of change in the front, middle and back office of the financial services industry

Suitable only for professional investors
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April 2018
Executive Summary (1 of 2)

• Artificial intelligence is here because the needed hardware and software have been built
  – AI requires hardware with massive computing power and data sets with millions of data points across many types of human activity, which have emerged from the web
  – There are 7.5 billion people but 20 billion smart computing devices, all with access to the storage and processing power of the Cloud, which is a $100 billion market
  – Venture capital has flown into Machine Learning companies at a rate of $5-10 billion per year

• There are various scientific approaches to building AI; the current relevant development is the advance in Machine Learning, and in particular neural networks and deep learning
  – Designing software by automating a process top-down is fundamentally different from leveraging AI techniques, which create probabilistic models that change in response to new data
  – Machines have developed the ability to derive information from sensory information, such as vision and sound, with an accuracy greater than humans
  – AI can also be used in a creative capacity to explore a space of ideas quickly or to do emotional tasks

• The growth and potential of Artificial Intelligence is a massive challenge for the traditional economy, and its development is likely to only accelerate
  – Most of AI research is publicly available through academic archives and much of the code is open source
  – Moore’s law suggesting exponential information processing continues to hold; current number of total scientific research submissions to ArXiv is 1.3 million, lines of open source code is likely over 100 million
  – Popularity of machine learning courses at top universities skyrocketed with compensation levels
  – Important to be grounded — today’s narrow Artificial Intelligence is not a panacea and does not have general reasoning capacity; but there are many practical applications of automated human judgment
Executive Summary (2 of 2)

• **Financial AI use-cases include conversational interfaces, biometrics, workflow and compliance automation, and product manufacturing in lending, investments and insurance**
  – In the front office, the most promising applications focus on integrating financial data and account actions with software agents that can hold conversations with clients, as well as support staff
  – In the middle office, as regulations become more complex and processes trend towards real-time, artificially intelligent oversight, risk-management and KYC systems can become very valuable
  – In product manufacturing, we see AI used to determine credit risk using new types of data (e.g., social media, free text fields), take insurance underwriting risk and assess claims damage using machine vision (e.g., broken windshield), and select investments based on alternative data combined with human judgment

• **Deploying AI across financial services has a $1 trillion potential impact**
  – In US alone, 2.5 million financial services employees are exposed to AI technologies
  – Potential cost savings of $490 billion in front office (distribution), $350 billion in middle office, $200 billion in back office (manufacturing), totalling $1 trillion across banking, investment management and insurance
  – Many firms talk about AI, few actually hold intellectual property in the space, which creates Black Swan risk

• **Future of AI in financials can take several routes; ethical and safety concerns are paramount**
  – One potential path is that AI tech companies like Amazon and Google continue to add skills to their smart home assistants, with Amazon Alexa sporting over 20,000 skills already, outcompeting finance companies
  – Another potential path is the example of China, where tech and finance merge (e.g., Tencent, Ant Financial) to build full psychographic profiles of customers across social, commercial, personal and financial data
  – A third path is towards decentralized autonomous organizations that are built by the crypto community to shift power back to the individual, with skills made from open source component parts
The Artificially Intelligent Corpus
The current metaphor for digitizing the physical world compares human brains with computer systems.

**Organic Nervous System in Physical Body**

- Events occur in the environment
- Sensors measure data about the event
- Information is sent for processing
- Processing checks new data against a mental model
- Reaction is triggered in response to event

**Virtual “Digital Twin” System for Mechanical Body**

Source: Autonomous NEXT
Note: See G.E. “Digital Twin” initiative
Artificial Intelligence, Big Data and IoT are closely connected

<table>
<thead>
<tr>
<th>Events occur in the environment</th>
<th>Theme</th>
<th>Human View</th>
<th>Machine View</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensors measure data about the event</td>
<td>Internet of Things</td>
<td>• Humans have general intelligence and respond to many stimuli, but only some events are observed and are relevant to our senses</td>
<td>• Machines are custom-built to react to specific events (narrow AI), but can be programmed to sense things humans cannot, like ultrasound</td>
</tr>
<tr>
<td>Information is sent for processing</td>
<td>Big Data</td>
<td>• Humans use our natural senses and the systems of the body to capture information and send it to the brain through the nervous system</td>
<td>• Machine sensors can be built for specific data and placed within objects to collect “Big Data”. Digital Twin projects from industrial companies render physical things in virtual worlds as a digital nervous system.</td>
</tr>
<tr>
<td>Processing checks new data against a mental model</td>
<td>Artificial Intelligence</td>
<td>• Different systems in the organism are used to measure and react to stimuli, from conscious/unconscious thought, to activations of emotions and hormonal systems</td>
<td>• Machines must structure the data they collect and find ways to store and process massive amounts of information, which only now has become possible with cheap computing power</td>
</tr>
<tr>
<td>Reaction is triggered in response to event</td>
<td></td>
<td>• The sensory experience has impacted a system, which has made a determination for action</td>
<td>• Upon receiving the data, a model will be updated, perhaps even changing the model, and an action will be caused</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• A person will withdraw a hand from the flame after processing a pain signal through the spinal cord and brain</td>
<td>• A self-driving car may change course on perceiving an obstacle</td>
</tr>
</tbody>
</table>

Source: Autonomous NEXT
The artificially intelligent corpus has seen both an increase in interest (from body to brain) and venture funding

**Google Trends (Sum of Terms)**

- Neural Network CAGR: 11.5%
- Machine Learning CAGR: 32.2%
- Big Data CAGR: 43.1%
- Internet Of Things CAGR: 29.6%
- Artificial Intelligence CAGR: 11.4%

**Venture Funding into AI companies**

- Venture for AI, machine learning, neural networks, data science, self-driving cars and chat agents continues to grow

**Source:** Autonomous NEXT, Google Trends, Pitchbook Data
North America has the highest deal count and invests the most capital, but Asia is gaining incremental share.

- North America has tended to dominate AI funding, but the role of Asia is rapidly increasing.

Source: Autonomous NEXT, Pitchbook Data
Hardware processors, via the emergence of Internet of Things outnumber human brains

Internet of Things vs Humans (billions)

Source: Economist, United Nations
Biggest beneficiaries of the infrastructure build are the high-tech firms, now competing for financial services data.

Source: Rightscale 2017 State of the Cloud Report, Oracle Cloud, Amazon Cloud
Hardware manufacturers of specialized hardware for machine learning have seen investment and appreciation.

Growth In Price Of NVIDIA Stock Vs SP 500 Index (01/01/2010 To 12/01/2017)

Source: Bloomberg, NVIDIA
The Machine Brain and its Senses
Understanding the chemistry of the AI ecosystem

- **Artificial intelligence has been an ongoing project since the 1950s**
  - Artificial intelligence, whether narrow or general, has been a focus of scientific research since the 1950s
  - AI has seen two boom-bust cycles -- in the late 1970s and again in the early 1990s -- where expectations, and associated investment, exceeded the results possible in that time period
  - However, much of the mathematical work underpinning current AI had been done in the last century and is now being implemented, which explains why current applications have grown so rapidly

- **Machine learning has experienced the most notable progress**
  - There are several high-level approaches to creating AI, but most participants in the ecosystem today talk about machine learning and deep learning when discussing the latest in artificial intelligence
  - Machine learning is a set of mathematical approaches, algorithms, and techniques that enable software to undergo a learning process that leads to a desired outcome
  - The recent explosion in the field is due to (1) the massive data sets generated by humans using the web, such as images and text, and (2) the use of “deep neural networks” that have been able to use greater available computing power to make sense, or even recreate, the data points in those data sets

- **Advances in applications that mirror human senses have again captured our imagination**
  - Unprecedented progress has been made in helping software agents process text, speech, music, sound, images, and video leveraging greater processing power
  - Not only can software understand the contents of inputs and categorize it at scale, but it has exhibited the ability to generate new examples of those inputs. Artists are as endangered as lawyers and bankers.
  - This technology is being commercialized and applied across industries, from media to healthcare and finance
  - Specialized hardware by companies like NVIDIA will accelerate processing speeds exponentially
The chemistry of the AI ecosystem

Artificial Intelligence

Approaches
- Expert Systems
- Evolutionary Algorithms
- Planning
- Machine Learning
  - Supervised
  - Unsupervised
  - Reinforcement

Select concepts
- Neural Networks
  - Recurrent
  - Adversarial
  - Generative
- Probability & Statistics
  - Bayesian Statistics
  - Markov Models
  - Graph Theory & Clustering
- Decision Trees & Random Forests

Sensory Applications
- Text
  - Natural Language Processing
    - Summarization
  - Translation
  - Sentiment Analysis
- Sound
  - Speech to Text
  - Speech Generation
  - Music classification
  - Music generation
- Image
  - Image recognition
  - Computer vision
  - Art identification and generation

Source: Autonomous NEXT, Machine Learning Mastery
Designing software by automating a process is fundamentally different from leveraging AI techniques

<table>
<thead>
<tr>
<th>Description</th>
<th>Top Down</th>
<th>Bottoms Up</th>
</tr>
</thead>
<tbody>
<tr>
<td>• To date, centrally-planned, deterministic systems have been the core of software development</td>
<td>• New approaches to computing and machine learning have ushered in an age of probabilistic models that behave like human intuition</td>
<td></td>
</tr>
<tr>
<td>• In such systems, the full model of inputs and outputs is known, and can be understood by tracing the progress of defined variables</td>
<td>• Knowing that something is likely is more useful than knowing something is true or false, and mirrors how the human mind is believed to work</td>
<td></td>
</tr>
<tr>
<td>• These systems efficiently automate repeatable tasks with known boundaries and desired outcomes</td>
<td>• The foundations for these approaches were laid decades ago, but new hardware has led to a resurgence in interest and precision</td>
<td></td>
</tr>
</tbody>
</table>

| Examples | | |
| Manufacturing a car in a factory using robots | • Recognizing cats in billions of photos |
| Rule-based workflow automation like Zapier.com | • Authenticating bank clients with their voice |
| High frequency trading using structured data | • Underwriting loans using social media data |
| Totalitarian communism | • Libertarian capitalism |
The automation of vision opens up many possibilities

Discussion

• In recent years, computer vision has become uncannily competent in recognizing and categorizing faces and a variety of objects

• This was in large part driven by big data available through Google images and Facebook photos

• Neural networks trained on a particular type of subject may prefer to have millions of examples, but once they are mapped for processing, they can be used at scale

• It has become trivial to recognize gender and age, and the technology is being extended into medical diagnostics and entire planet indexing

• The next dimension is time – video can be processed similar to static images to build self driving cars, which require powerful chip hardware

Source: Howold.net, Tesla
Machine vision error rates have decreased below human vision error rates

Error Rate in Image Recognition in the ImageNet Competition (%)

- 2010: 28.2
- 2011: 25.8
- 2012: 16.4
- 2013: 11.7
- 2014: 7.3
- 2015: 6.7

Human visual recognition error rate at 5%
Machines make mistakes where we do not, but at a lower rate

• ImageNet is a project focused on powering visual object recognition software
• The ImageNet Challenge has been run since 2010, where teams of data scientists and developers compete to achieve high accuracy on machine vision tasks
• A break through in 2012, using neural networks on modern hardware, paved the way for machine vision that is more accurate than human vision on this particular data set

How does a Neural Network work?

**Discussion**

- There are different architectures to neural networks, of which the most recent developments are in (1) **deep feedforward neural networks** and (2) **recurrent neural networks**

- The key variables are:
  - **Neurons** that receive, process, or output information
  - **Connections** that transfer data between neurons
  - **Weights** for each connection that create relative importance within the network of the data
  - **Learning rules** that changes the weights and other attributes of the network in response to new data and in accordance with either learned outcomes or optimization functions
  - **Layers** of neurons that bundle certain neurons into a group if they are to perform a similar function, such as data transformation (convolution), though these are not required or always present

**Illustrative Example**

<table>
<thead>
<tr>
<th>Layer 1</th>
<th>Layer 2</th>
<th>Layer 3</th>
<th>Layer 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>Hidden</td>
<td>Hidden</td>
<td>Output</td>
</tr>
</tbody>
</table>

*Source: Manning, Wikipedia*
What does that really mean?

Every feature map output is the result of applying a filter to the image. The new feature map is the next input.

- In these examples, the images are transformed with various filters – from those that look at the entire composition of the images, to those that trace edges and find granular shapes – in order to create several additional maps on which correlate with particular objects, like cats, dogs, faces or emotions.
Artificial Intelligence can also be creative by hallucinating image styles and objects, using similar data architecture

Discussion

- In teaching software how to sense the world, scientists have created the wiring that identifies certain outputs

- That wiring can be run in a reverse direction, generating output rather than judging input

- For example, neural networks have learned the style of all painting masters, can be used to identify forgeries, and then can be used to hallucinate style onto any image or video

- Generative design systems can use algorithms to solve for defined constraints, like load or function, and could incorporate the approaches from machine learning

- Creativity, as a function of idea cross-pollination and novelty, can be automated through software that has evolutionary utility functions

Source: Pikazo, Autodesk Within, Professional Work Station
The automation of text recognition and speech generation is enabling the rise of Conversational Interfaces

Source: Mastercard, Amazon, Google

Discussion

- Conversational interfaces use multiple machine learning techniques from Speech Recognition to Natural Language Processing

- These techniques take sound and transform it into machine-readable data, and then extract meaning and emotion in order to frame the appropriate designed response

- Virtual assistants in the form of chatbots or speaking computers are the next operating system for tech companies and will dominate self-driving cars and the smart home

- Google Home and Amazon Alexa are powering the smart home; Facebook Messenger and WeChat lead texting chatbot adoption

- Developers can already plug into these ecosystems and build voice/text apps
And in reverse – neural networks can write infinite Shakespeare, or tight journalism copy

A neural network fed on all Shakespeare plays can endlessly regurgitate similar-sounding verse

Startups like Narrative Science, which has raised $43 million to date, commercialize speech generation over data sets across industries

Source: Andrej Karpathy, Narrative Science, Crunchbase
More capabilities are being created through projects like Google’s DeepMind, which focuses on core research

Google DeepMind has a scientific mission to push the boundaries of Artificial Intelligence, moving from narrow to general applications.

- Responsible for building the winning AlphaGo software, which defeated all human opponents, who later described it as “creative”, “beautiful”, and a “Go god”
- Commercial applications include optimizing energy usage across Google’s cloud server infrastructure and working with the healthcare industry to improve service levels
- Employed scientists produce open academic research, publishing over 150 peer reviewed papers
- Major recruiter of young talent out of universities, competing with Facebook and IBM Watson

**Overview**

- Raised: $27 million
- Founded: 2010
- Acquired: $650 million from Google

**Employee Count**

<table>
<thead>
<tr>
<th>Year</th>
<th>2014</th>
<th>2013</th>
<th>Apr-16</th>
<th>Oct-16</th>
<th>Apr-17</th>
<th>Oct-17</th>
<th>Apr-18</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>75</td>
<td>105</td>
<td>165</td>
<td>247</td>
<td>384</td>
<td>451</td>
<td></td>
</tr>
</tbody>
</table>

Source: Autonomous NEXT, Pitchbook, LinkedIn
Two key machine learning frameworks are battling for dominance, backed by Google and Facebook

**TensorFlow**
- Open source software library that was built at Google Brain (later DeepMind) and then open sourced
- Can scale down from desktops and servers to mobile devices, which is important for building AI-first consumer habits
- Highly active Github code repository
  - 31,000 commits (i.e. code contributions)
  - 1,400 contributors
- Used by Airbnb, AMD, Nvidia, Uber, Dropboc, ebay, Snap, Intel, Twitter, Lenovo and countless others

**PyTorch**
- Open source software built on top of the powerful Python programming language, and its extension Numpy, which has a deep quantitative library
- Used as the machine learning framework by Facebook, and several developer leads are Facebook engineers
- Designed to be fast and lean in terms of memory usage, can run on CPUs and GPUs
- Highly active Github code repository
  - 10,500 (i.e. code contributions)
  - 600 contributors

… and others
- Theano
- Caffe
- CNTK
- Amazon Machine learning
- Apache Singa
- Microsoft CNTK
- Torch
- Accord.NET
- Apache Mahout
- Brainstorm
- Spark MLlib

Source: TensorFlow, Pytorch, Github
Deploying AI in Financial Services & Economic Impact
$1 trillion in savings from AI implementations by 2030

• As the services economy is incrementally automated with judging machines, financial professionals are highly exposed
  – In US alone, 2.5 million financial services employees are exposed to AI technologies in front, middle and back office; 1.2 million working in banking and lending, 460,000 in investment management, and 865,000 in insurance
  – These functions will see 20-40% productivity gains, or unemployment, depending on your vantage point

• Total impact across financial sectors is $1 trillion, a 22% traditional cost reduction
  – Estimates are built from financial company public filings, global revenue pools, and granular analysis to assess likelihood of automation
  – Banking industry to see $450 billion in AI impact, which is a 25% reduction of the traditional cost base
  – Investment Management industry to see $200 billion in AI impact, which is a 38% reduction of the traditional cost base
  – Insurance industry to see $400 billion in AI impact, which is a 14% reduction of the traditional cost base
  – Reconfigured, this suggests impact of $490 billion in front office, $350 billion in middle office, $200 billion in back office

• Long-run market opportunity of $500 billion to build financial AI companies by 2030
  – To catalyze change from industry incumbents, new solutions must be meaningfully more economic than the traditional cost base which AI displaces
  – We expect 10% of that traditional cost base to be captured by 2025, and 50% by 2030
  – $100 billion for manufacturing, $250 billion for distribution, and $175 billion for middle office
  – But this could be stymied by software failure or limitations from regulation

Artificial Intelligence is being applied across Financial Services

Fintech AI Use-cases

More Mature
Less Mature

Payments  Banking  Capital Markets  Investment Management  Insurance

Front Office
Distribution

Chatbots
Voice Assistants
Authentication and Biometrics

Middle Office

Monitoring
Anti-fraud & Risk  KYC / AML  Complex Legal & Compliance Workflows

Back Office
Manufacture

Credit Underwriting  Alternative Data in Trading and Asset Management  Risk Underwriting  Smart Contracts Infrastructure

Source: Autonomous NEXT
AI technologies impacting Financial front office

**Fintech AI Usecases**

- **Chatbots**
  - A conversational interface inside a messaging platform, such as Facebook Messenger or Slack, that can be the new front line to customer service
  - Uses Natural Language Processing to understand typed text and its various permutations and matches inquiries with decision trees around platform functionality
  - Could be used to initiate tasks as well as provide information

- **Voice Assistants**
  - A conversational interface as part of a voice-first platform, such as Amazon Alexa or Google Home
  - If general AI assistants become the touch point for commerce and client interaction, then financial products will be integrated as a narrow skill inside the broader functionality
  - The software translates sound data to text prior to applying NLP
  - Companies like Soul Machines are working on combining voice technology with 3D rendered avatars to serve as customer service agents; others are building physical robots

- **Authentication and Biometrics**
  - Biometrics use the unique physical attributes of an individual to connect them with their identity
  - As an example, a bank may rely on the thumbprint or facial recognition captured by a smart phone to authenticate a mobile payment
  - Alternately, a bank may use voice recognition as a password to customer service, rather than a numerical passcode

Source: Autonomous NEXT
AI technologies impacting Financial middle office

Fintech AI Usecases

- Regtech implementation of AI vary according to industry, but one core capability is ongoing monitoring of company communications, financial transactions, vendors, brand reputation, or employee biometrics
- AI can be trained to recognize unusual activity and generate certain actions if fail-safes are crossed
- As an example, if a capital markets trader shows unusually high heart rate, access to trading capital could be reduced or frozen

- Compliance analysis is shifting from examining a selected sample of all transactions in a batch process (e.g., 5% of a month) to a continuous AI evaluation of every single transaction in real time
- Particularly true for e-commerce and payments systems, which must make credit decisions in near real-time on millions of transactions

- Tying identity to a KYC/AML compliance process at scale is being accelerated by AI technology
  - For example, image recognition of a passport may be used to compare an individual to an image in a store database, or similarly converting image text to regular text automates the process further

- Many vendors take a holistic compliance automation approach, and tie together data collection at scale, using both structured and unstructured sources (e.g., social network analysis for corporate affiliates) with checks against particular regulatory rules
- Legal documents can be analyzed using machine learning to transform them into structured data and compare the differences

Source: Autonomous NEXT
AI technologies impacting Financial back office

Fintech AI Usecases

Front Office

Middle Office

Back Office

- Companies like Lending Club and OnDeck initially used human data scientists to create algorithms for fast underwriting of loans to individuals and businesses.
- Given today’s data sets, machine learning can automatically power simple credit underwriting models, depending on the data ingested.

- Insurance underwriting can similarly use machine learning on applicant data to price policies.
- Additionally, insurance companies can use machine vision to assess claims, such as accident damage to a car, flooding damage to a house, or yield damage to crops.

- Investment management is a less well-defined problem for AI, and as a result progress has been slower.
- However, alternative data sets that leverage machine vision (e.g., imaging the planet) or other AI skills are actively used by investors.
- Within trading, AI can create intelligence about market participants.
- The work of research analysts is being partially automated as well.

- While smart contracts infrastructure is still being developed in the crypto economy (e.g., Ethereum, Hyperledger), there have already been experiments with Decentralized Autonomous Organizations.
- DAO are functional corporations that can use human consensus or machine thinking to interact with the real economy.

Source: Autonomous NEXT
Methodology for estimating impact on financial industry

Revenue Pool
- Build out estimates for global industry revenue pools across Banking, Insurance, and Investment Management
- Use company filings, geographic economic activity and population splits, and consultant estimates

Industry P&L
- Using public filings of leading financial companies, estimate cost basis and profitability across industries
- Adjust according to industry knowledge

Eligible Costs
- Review public filings across dozens of companies for common line-items that could be subject to AI disintermediation and automation
- Exclude automation that does not stem from the AI corpus, i.e., creation of big data, associated hardware and software, and changing business models

AI Impact
- For each line item, estimate likely impact of introducing and commercializing emerging technologies, based on comparables (e.g., Norwegian mobile banking) or extrapolated judgment
- Sanity check derived totals against other financial industry estimates

New Opportunity
- In the growth scenario, assume that 50% of the AI-led savings will be translated into technologies that displace the prior service model, forming a new revenue pool for AI fintech in 2030
- The AI impact numbers should be counterbalanced by the costs of restructuring and new solutions

Source: Autonomous NEXT
In US alone, 2.5 million financial services employees are exposed to AI technologies in front, middle and back office

### Banking

<table>
<thead>
<tr>
<th>Role</th>
<th>AI Employment Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tellers</td>
<td>485</td>
</tr>
<tr>
<td>Customer service representatives</td>
<td>219</td>
</tr>
<tr>
<td>Loan interviewers and clerks</td>
<td>174</td>
</tr>
<tr>
<td>Financial managers</td>
<td>96</td>
</tr>
<tr>
<td>Compliance officers</td>
<td>13</td>
</tr>
<tr>
<td>Loan officers</td>
<td>250</td>
</tr>
</tbody>
</table>

- **1.2 million people exposed to AI employment impact**
- **70% in the front office**
- **10% in middle office**
- **20% in the back office**

### Investments

<table>
<thead>
<tr>
<th>Role</th>
<th>AI Employment Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Securities, commodities, and financial services</td>
<td>162</td>
</tr>
<tr>
<td>Personal financial advisors</td>
<td>138</td>
</tr>
<tr>
<td>Brokerage clerks</td>
<td>45</td>
</tr>
<tr>
<td>Financial managers</td>
<td>32</td>
</tr>
<tr>
<td>Compliance officers</td>
<td>15</td>
</tr>
<tr>
<td>Financial analysts</td>
<td>71</td>
</tr>
</tbody>
</table>

- **460 thousand people exposed to AI employment impact**
- **75% in the front office**
- **10% in middle office**
- **15% in the back office**

### Insurance

<table>
<thead>
<tr>
<th>Role</th>
<th>AI Employment Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insurance sales agents</td>
<td>370</td>
</tr>
<tr>
<td>Insurance claims and policy processing clerks</td>
<td>-</td>
</tr>
<tr>
<td>Managers</td>
<td>-</td>
</tr>
<tr>
<td>Compliance Officers</td>
<td>-</td>
</tr>
<tr>
<td>Claims adjusters, examiners, and policy processors</td>
<td>194</td>
</tr>
<tr>
<td>Insurance underwriters</td>
<td>80</td>
</tr>
</tbody>
</table>

- **865 thousand people exposed to AI employment impact**
- **43% in the front office**
- **35% in middle office**
- **32% in the back office**

Total impact across financial sectors is $1 trillion, a 22% traditional cost reduction

Banking

<table>
<thead>
<tr>
<th>Revenue</th>
<th>Operating Margin</th>
<th>Costs</th>
<th>Unrelated Costs</th>
<th>AI-Eligible Costs</th>
<th>AI Impact</th>
<th>Remainder</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,255</td>
<td>902</td>
<td>1,353</td>
<td>506</td>
<td>847</td>
<td>447</td>
<td>400</td>
</tr>
<tr>
<td>40%</td>
<td></td>
<td>22%</td>
<td></td>
<td></td>
<td>20%</td>
<td></td>
</tr>
</tbody>
</table>

Investment Management

<table>
<thead>
<tr>
<th>Revenue</th>
<th>Operating Margin</th>
<th>Costs</th>
<th>Unrelated Costs</th>
<th>AI-Eligible Costs</th>
<th>AI Impact</th>
<th>Remainder</th>
</tr>
</thead>
<tbody>
<tr>
<td>754</td>
<td>226</td>
<td>528</td>
<td>151</td>
<td>377</td>
<td>199</td>
<td>178</td>
</tr>
<tr>
<td>33%</td>
<td></td>
<td>13%</td>
<td></td>
<td></td>
<td>26%</td>
<td></td>
</tr>
</tbody>
</table>

Insurance

<table>
<thead>
<tr>
<th>Premiums (excludes Other Revenue)</th>
<th>Operating Margin</th>
<th>Costs</th>
<th>Unrelated Costs</th>
<th>AI-Eligible Costs</th>
<th>AI Impact</th>
<th>Remainder</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,339</td>
<td>434</td>
<td>2,905</td>
<td>577</td>
<td>2,328</td>
<td>392</td>
<td>1,937</td>
</tr>
<tr>
<td>13%</td>
<td></td>
<td>17%</td>
<td></td>
<td></td>
<td>12%</td>
<td></td>
</tr>
</tbody>
</table>

Source: Autonomous NEXT estimates
Other studies send similar message -- 20-40% impact on human employment and productivity at $1T level

- Our bottoms up analysis is consistent with other studies about the expected size of the impact from Artificial Intelligence on financial services.
- Bain sees a potential $5.4 trillion shortfall in GDP by 2030, which would translate to $1.1 trillion of associated GDP in the financial sector.
- Accenture sees AI adding $1.2 trillion in financial services value by 2035.

Large opportunity across distribution, middle office, and manufacturing to implement new solutions

Sizing the Opportunity

- In the next several pages, we dive more deeply into the impact due to each part of the financial firm in order to understand the importance and size of each theme (e.g., chatbots, AI-funds, automated KYC)

- We then combine the pieces to arrive at a revenue pool for new solutions that will succeed in this space

- Operating executives will implement AI based software and go through restructuring only if it is meaningfully cheaper than existing alternatives; we assume a 50%+ cost reduction as such a trigger

- Thus, the $1 trillion of impact would not be fully absorbed as cost savings, but would be mitigated by the introduction of new solutions, albeit at a lower price point

- Further, such reductions are likely to be industry wide, allowing for a competitive advantage in the short term, but not long term

- The translation of this value into commercially successful production software will happen on a 10 year time horizon, which drives our 2030 timeline

Impact of AI by Function of Financial Firms($B)

Source: Autonomous NEXT estimates
Front Office – Potential cost savings of $490 billion

Estimated Cost Exposure by Industry with Impact ($B)

- We estimate that the following costs related to distribution can be reduced through artificial intelligence technology

- $326 billion of Banking industry cost can be reduced by 61%, by targeting retail branches, security, tellers and cashiers, and other distribution staff, resulting in a reduction of $199 billion

- $208 billion of Investment Management cost can be reduced by 60%, by targeting financial advisors and associated infrastructure and client service support, resulting in a reduction of $125 billion

- $336 billion of Insurance industry cost can be reduced by 50%, by targeting insurance sales staff, customer service agents, and commissions, resulting in a reduction of $168 billion

Source: Autonomous NEXT
Middle Office – Potential cost savings of $350 billion

We estimate that the following costs related to the middle office can be reduced through artificial intelligence technology:

- $459 billion of Banking industry cost can be reduced by 47%, by targeting Compliance, KYC/AML, authentication and data processing, resulting in a reduction of $217 billion.

- $63 billion of Investment Management cost can be reduced by 50%, by targeting Compliance, home office compensation, workflow and trading systems, and other data processing, resulting in a reduction of $32 billion.

- $495 billion of Insurance industry cost can be reduced by 20%, by targeting Compliance, information services, workflow and accounting systems, and other data processing resulting in a reduction of $99 billion.

Source: Autonomous NEXT
Back Office – Potential cost savings of $200 billion

We estimate that the following costs related to product manufacturing can be reduced through artificial intelligence technology:

- **$62 billion of Banking industry cost** can be reduced by 50%, by targeting credit underwriting and collection systems and related professional compensation, resulting in a reduction of **$31 billion**

- **$106 billion of Investment Management cost** can be reduced by 40%, by targeting portfolio manager compensation and associated research costs, resulting in a reduction of **$42 billion**

- **$1.5 trillion of Insurance industry cost** can be reduced by 8%, by reducing claims due to higher underwriting accuracy, as well as targeting claims assessment, resulting in a reduction of **$125 billion**

Source: Autonomous NEXT
Revenue Pool for AI startups in financial services to reach $500 billion by 2030, over $100 billion by 2025

Revenue Pool for Fintech AI
($ Billions, Growth Case)

- We expect 10% of potential value to be captured by 2025, and 50% of AI impact by 2030
- $100 billion for manufacturing, $250 billion for distribution, and $175 billion for middle office

Revenue Pool for Fintech AI
($ Billions, Conservative Case)

- In the conservative case, long term value is capped due to failure to deliver on technology’s promise, or a regulated limitation on its deployment
Front Office: Chatbots & Conversational Interfaces
The power of conversational interfaces across industries

• Consumer preferences continue to shift to new media channels, and are starkly divided among generational lines
  – 90% of the Silent Generation (born 1925-1945) have a preference towards human service over the phone, while only 12% of Millennials prefer phone, with nearly all others looking for chat, social or text channels
  – Conversational interfaces like chat and voice are powered by natural language processing, and are the natural evolution after the mobile web, simplifying experiences from managing dozens of apps to one stream

• Secular trend of reducing front office staff and retail footprint in favor of tech-enabled communication and products, through mobile wallets, apps, and conversational interfaces
  – On average, people have 6 financial apps on their phone – but there are dozens of thousands of banks, credit unions, and financial advisors that have to compete for those spots
  – Norway is an example of digital banking leading to a shrinking in the branch footprint and shifting consumer behavior; and Asian countries show 50%+ adoption of mobile payments over traditional methods

• Rich ecosystem of startups working on the client experience across banking, payments, investments and insurance, leveraging platforms like Amazon Echo and Facebook Messenger
  – To build a chatbot or voice channel, developers need to select from (1) competing open-source frameworks and private platforms that power machine learning and associated NLP, and (2) the end points that touch consumers, from Slack, Skype, Messenger, Telegram and several large Asian tech players
  – Chatbot platforms can be consumer facing as direct distribution channels, as well as private label platforms for banks and financial institutions to more cheaply serve their customers
  – However, this software is still in the early stages, and the best use-cases are those where chat agents respond to low-level requests (e.g., balance inquiries) while humans manage more complex cases
Generational divide in service preference shows Millennials prefer chat and social media to telephone

Most Popular Channels for Contact Centers by Generation (2015)

First Four Years after Launch (Active Users in Millions)

Source: Autonomous Research, KPCB and Dimension Data 2015
A chatbot is an automated call center with machine empathy built in the place where Millennials communicate.
Will there be room for human relationships in a winner-take-all tech platform, like iOS or Android?

### Number of Select Financial Institutions in the United States

- **Commercial Banks**: 6,799
- **Credit Unions**: 5,996
- **Registered Investment Advisors**: 11,500
- **Family Offices**: 7,070
- **Hedge Funds**: 8,000
- **Private Equity Firms**: 3,530

### Number of Apps on Phones (2017, n=200 bloggers)

- **Total # of finance apps used by bloggers**: 882
- **Average # of finance apps used by bloggers**: 6
- **Highest # of finance apps used by a blogger**: 35
- **Lowest # of finance apps used by a blogger**: 0

- **Total # of overall apps used by bloggers**: 8978
- **Average # of overall apps used by bloggers**: 66
- **Highest # of overall apps used by a blogger**: 217
- **Lowest # of overall apps used by a blogger**: 4

- **10% is financial**

- **Plethora of small financial distributors and manufacturers to serve the long tail**

- **Centralized platform limited by attention means 6 financial spots on average**

Source: Autonomous NEXT, Rockstar Finance, FDIC, Reuters, SEC, BCG
It is possible to decrease reliance on legacy client servicing, see Norway as a leader in digital banking ....

- Percentage of clients that visit a physical bank branch at least monthly has decreased from 50% to 10% between 2002 and 2016
- Conversely, percentage of clients that use the bank app at least weekly is at 80% in 2016

Source: Autonomous Research, Finance Norway
... or mobile wallet penetration in developing countries

<table>
<thead>
<tr>
<th>Mobile Wallet Adoption (2016, % by Country)</th>
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<tbody>
<tr>
<td>Country</td>
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<tr>
<td>---------</td>
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<tr>
<td>India</td>
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<tr>
<td>Thailand</td>
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<tr>
<td>Indonesia</td>
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<tr>
<td>Mexico</td>
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<tr>
<td>UAE</td>
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<tr>
<td>Brazil</td>
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<tr>
<td>Singapore</td>
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<tr>
<td>Spain</td>
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<tr>
<td>Italy</td>
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<tr>
<td>Sweden</td>
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<td>South Africa</td>
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<td>U.S.</td>
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<td>Canada</td>
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<td>U.K.</td>
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<td>Germany</td>
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<td>Hungary</td>
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<table>
<thead>
<tr>
<th>Mobile Wallet Adoption (Delta 2012-2016, Change in %)</th>
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<tbody>
<tr>
<td>Country</td>
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<tr>
<td>---------</td>
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<tr>
<td>U.K.</td>
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<tr>
<td>Germany</td>
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<tr>
<td>Singapore</td>
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</tbody>
</table>

- India, Thailand, and Indonesia show 50% mobile wallet adoption, nearly double the 28% average, and nearly triple that of the United States
- High absolute penetration growth has happened in the developing world, with the US trending around the average

Source: Autonomous NEXT, Aite Group
Financial chatbot & conversational interface ecosystem

User Interaction layer: Voice & Messaging

Closer to Client

General Purpose Assistants
- Alexa
- Siri
- Cortana
- Google Assistant
- Facebook M

Developer Tools: Frameworks and AI engines
- Microsoft Azure
- Google
- IBM Watson
- Microsoft
- Amazon
- Intercom
- Slack
- Skype
- Twilio
- Viber
- WeChat
- Google Home

High Tech Incumbents
- FinTech & Payments
- General Purpose Assistants

Financial Incumbents
- Banking & Lending
- Investing
- Payments

Private-Label Platforms
- General Purpose Assistants
- Private Label

Investing
- UBS
- TD Ameritrade
- Kasisto
- Teller
- Abe
- Bond.AI
- Dobot
- Stockflare
- Insurify
- SPIXII
- Next Insurance
- Lemonade
- LeO:

Insurance
- General Purpose Assistants
- Private Label

Lending
- Habito
- Funds Tiger

Budgeting & Savings (Personal Finance Management)
- General Purpose Assistants
- Private Label

Wallet & Payments
- General Purpose Assistants
- Private Label

Source: Autonomous NEXT, Botlist.co, BootstrapLabs, VentureBeat
B2B offerings for banks starting to integrate core banking systems into conversational interfaces (chat / voice)

IBM core strategic bet on Artificial Intelligence as a Service.

Started out paired with internal VC, then opened to external developers, then productizes into API, tech + services

Unavoidable cost of training and setup ($250K+)

How will Facebook and FISERV be integrated?

Productivity uplift for the middle office & the customer service reps

Source: IBM Watson, Finn.ai, Kasisto
Example of private-labeled chatbot platform

**Overview**

- The company provides banks with a chatbot technology that integrates into core processors and conversational apps (e.g., Messenger)

- Currently working with T1 and T2 banks across 4 continents, Finn.ai is automating hyper-frequency front office tasks that results in up to 50% time savings for support staff

- The system is a rule-based agent, making decisions based on a given set of scenarios

- Company uses data aggregator, MX, which extracts consumer information from their online banking services.

- Plans to use machine learning and voice recognition to create ‘behavior profiles’, allowing users to receive personalised advice based on their characteristics, sentiments and cash flows

Source: Autonomous NEXT, Finn.ai
Middle Office: Regtech & Identity
Compliance and workflows bolstered by AI

• Increasing regulatory complexity and the consumer expectation of real-time products and services is putting significant pressure on financial institutions
  – Nearly 30,000 pages of financial regulation have been added in the United States alone, and this has led to billions of venture capital funding for the regulation technology (RegTech) category
  – As products are provided in real time, compliance functions and fraud/risk management must shift from a batch process approach that tests samples of clients to an “always-on” approach for every transaction

• Artificial Intelligence cannot be built without large, open, live structured data sets – the regulatory initiatives of PSD2 and GDPR are catalyzing the opening of bank financial APIs, which will make it possible for third parties to access permissioned client data
  – PSD2 creates a way for machines to access data that is of a higher quality than the screen scraping tools developed in the United States during the mid 2000s
  – GDPR creates rights to data privacy and portability, which has implications for financial services infrastructure, and the legacy core systems that may be unable to flex for full compliance

• AI systems in the middle office are designed for financial institutions, and span from specific use-case applications to broad compliance and risk management platforms
  – Machine vision can be used to scan faces in passports or live photos and authenticate users; similar approaches can be applied to voice data, behavioral data and other biometric identity markets
  – Vendor and customer risk management can be automated with robots that index the web’s unstructured data and monitor changes and threats in real time
  – Machine learning can also be turned inwards towards employee communication for ongoing monitoring and threat prevention of trading or other behavior, useful in businesses with exposure to client capital
Complexity of middle office requirements has risen, as has funding for companies using software to lighten the burden.

- The last decade has seen a steady increase in writing dedicated to financial regulation.

- To deal with the increasing complexity of regulation, compliance and fraud, early stage investors have been funding RegTech as a theme.

**Cumulative Pages of Financial Regulation Since 2000**

**Venture Capital Funding in RegTech & Fraud Prevention**

Source: Autonomous Research, Mercatus Center
Increasing regulatory cost and complexity requires industry platforms

Overnight Batch
Analyze Data Samples

Real-time APIs
Analyze every transaction

Internal compliance capability

Workflow Automation

Artificial Intelligence

• Two key variables are driving the need for artificial intelligence in the middle office

• First, the middle office is seeing increased stress from regulatory complexity, i.e., interpreting and implementing financial regulation at scale, such that an outsourced platform is a cheaper solution than in-house development

• Second, consumer technology and expectations have moved from periodic to real-time, meaning that transactions are instantaneous, or appear to be so.

• This implies that various middle office processes, from KYC/AML to account opening or money movement must embed regulatory checks into real-time transactions rather than batch processes where only samples are analyzed

• Further regulation, like PSD2, creates to a real-time, API-based data world, which is a requirement for AI to function
Banks are opening Developer Portals for third parties to leverage their APIs – mandated, but still a surprise to see.

The key to successful APIs is whether the software can merely read information, or whether it can actually move money, open accounts, and take account actions.

The theme of “bank-as-a-service” is enabled through the most competitive financial APIs, similar to the iOS and Android app stores.

Chatbot companies and AI-giants like Amazon will leverage such APIs for integration with conversational interfaces.
Such efforts have already been undertaken by industry in the United States, but using a screen-scraping backdoor.

- In the United States, a wave of account aggregation companies were started in the early 2000s, pioneered by eWise, Yodlee (banking) and ByAllAccounts (investments).

- The data was aggregated from the user side, rather than via APIs. This means either downloading an OFX file from the bank (used in personal finance software) or by “screen-scraping” the website for account information after getting login credentials from the user.

- Mint.com was the most notable example of personal financial management software using this approach, leveraging Yodlee for data and eventually selling to Intuit for $170M.
Market Landscape for AI and Advanced Analytics Regtech

- **KYC / AML**
  - Trulioo
  - ComplyAdvantage
  - Entify
  - encompass
  - Digital Identity
  - kompli-global
  - verato

- **Biometrics & Identity**
  - BioCatch
  - Cydentify
  - OmniPerception
  - APL
  - Trueface.ai
  - ThisIsMe

- **Compliance Workflows**
  - NeotaLogic
  - Cognitive Scale
  - Corlytics
  - contracts
  - Governance.io
  - Suade
  - FUNDAPPS

- **Cyber Security**
  - Darktrace
  - Forcepoint
  - Nehemiah Security
  - RiskIQ
  - Awen Yaut
  - VECTRA
  - Amazon Web Services

- **Diligence & Vendor Risk Management**
  - kompli-global
  - Arachnys
  - DueDil
  - Intix
  - Security Scorecard

- **Financial Risk Management**
  - AlgoDynamix
  - AQMetrics
  - Argos Risk
  - CreditPoint
  - Able Markets

- **Surveillance / EComms**
  - BEHAVOX
  - ANCOA
  - humansafe
  - Stride
  - Sparkcognition
  - AVORA

- **Fraud Detection & Prevention**
  - NetGuardians
  - ThreatMetrix
  - Provenir
  - feedzai
  - IBM Watson
  - zensed

- **Operating Use-Cases**
  - Source: Autonomous NEXT

Complex, multi-step processes

Closer to Client

Closer to Infrastructure

Transactions

Source: Autonomous NEXT

58
Example of machine learning solution for Compliance

Overview

- Synthesys® cognitive computing platform is able to holistically analyze huge volumes, multiple streams and forms of data
- By unifying data around a customer, their activities, needs and intentions, cognitive computing uses machine learning and natural language processing to understand what customers are talking about, their sentiment and buying behaviors
- Deploys bespoke solutions for multiple use-cases across industries:
  - Understanding financial markets
  - Customer profiling, relationship management and cross-selling
  - Government analytics
  - Conduct surveillance and risk management within internal communications
- Investors include BNP Paribas, Barclays, Goldman Sachs, Square Capital, and Nasdaq

Raised: $140 Million

Founded: 2000

Tennessee, USA

SYNTHESIS HELPS COMPLIANCE ANALYSTS DETECT:

- Market manipulation
  - Reveal collusion and market manipulation
  - "Quid-pro-quo" exchanges
  - Clustered Bid/Ask Quotes
  - Order execution around the benchmark
- Unauthorized trading
  - Identify trade abuse
  - Deal-related language
  - Abusive/dirty references
  - Improper placement and execution
- Wall cross violations
  - Uncover insider trading
  - M&A terminology
  - Personal trade execution
  - Discussing Companies on Restricted List

Source: Autonomous NEXT, Digital Reasoning
Back Office: Financial Product Manufacturing using AI
AI-lead product manufacturing goes to the heart of Finance

- Quantitative methods have always been used to manufacture financial products – from loans, to insurance, to picking investments – but applying machine learning is a new challenge
  - There is a distinction between Data Science, a discipline practiced by human statisticians to build algorithms, and Machine Learning, a discipline where human engineers build machine statistician algorithms that write their own algorithms

- Artificial Intelligence is most useful where the problem set is narrowly defined, i.e., it is well known what is being optimized and how, and where the fuzzy data needs the structuring at scale that AI provides
  - A narrowly defined problem may be – given this particular set of personal characteristics about a person, should they be allowed to borrow this particular amount of money based on prior examples. A poorly defined problem may be – predict the price of a stock tomorrow given thousands of inter-correlated data points and their price history.
  - Insurance data sets, like photos of damage to insured objects, seem particularly well suited to the type of work that AI does well

- Until now, most Fintech companies have transformed and automated the client experience. Using AI to automated the manufacturing of financial products could lead to a fundamental shift in the heart of the industry.
  - In response to passive factor-based asset managements, investors are racing to build augmented investment analysts that make selections based both on fundamental analysis and alternative data interpreted by AI
  - Looking at the Asian fintech giants like Baidu and Ant Financial shows us how powerful an AI profiling mechanism can be if given access to social, commercial, and behavioral data in addition to financial data
AI is most powerful for financial products where data is unstructured but the goals are narrowly defined

- **Credit:** AI Solves the narrow problem of whether to provide a consumer or business credit, and does so leveraging structured data like financials, zipcode, age, salary and savings

- **Insurance:** Within underwriting, AI can attempt to minimize losses from decisions; and within claims assessment it can incorporate unstructured data sets like images of broken cars and houses, or health data

- **Investment management:** Still learning how to define a problem set narrow enough not to be overwhelmed by noise and unachievable goals, but progress has been made in AI-enhanced trading and alpha-generating hypothesis formulation and testing

Source: Autonomous NEXT
Market Landscape for AI in Product Manufacturing

**Banking & Lending**
- Affirm
- Upstart
- Aire

**Credit Underwriting**
- naborly
- OPTACREDIT
- zestfinance
- Wecash
- ADF
- JAMES

**Repayment and Collections**
- TrueAccord
- Pairity
- specto

**AI /Quant funds and software**
- NUMERAI
- AIDYIA
- Teza
- BlackRock
- CITADEL
- BOSTON

**Claims /Risk Management**
- Galaxy.AI
- flamingoAI
- Shift Technology
- UNDERSTORY

**Augmented Analyst**
- agolo
- PRIMER
- narrative
- prattle

**Underwriting**
- Cytora
- tröv
- CARPE DATA
- DreamQuark

**Investment Management**
- Quantopian
- Quantiacs
- BINATIX
- TICKERMAN
- WATSON

**Incumbents**
- Zhejiang Insurance
- Allstate
- Allianz

Source: Autonomous NEXT, Coverager, Oxbow Partners
Example of an AI-based lending underwriter

Upstart

Overview

• Founded by ex-Googlers, Upstart is a direct-to-consumer lending platform as well as a provider of lending-as-a-service via its ‘Powered by Upstart’ technology to banks and credit unions

• Upstart leverages artificial intelligence and machine learning to power its underwriting engine to identify high quality borrowers using variables such as:
  • Schools attended
  • Work experience
  • Neighbourhood
  • Web behaviour during the online application process

• Resulting in instant approval of over 30% of all loan applications.

• With the average size of each loan being $11,500 to a customer of average age 28, Upstart have been able to originate over $1.7B in loans to date.

Source: Autonomous NEXT, Upstart
**Example of an industry-leading Quantamental fund**

**BlackRock**

**Overview**

- BlackRock is embracing quantamental strategy by placing its Scientific Active Equity unit at the core of its fundamental stock-picking products. This is separate from its quantitative, factor driven smart beta products.

- The unit and its 80 staff (of which 30 are PhDs) use alternate data sources to enhance the fundamental decision making process:
  - Satellite imagery to understand extent of commercial activity and traffic patterns
  - Conference call transcripts to interpret current affairs, using semantic analysis and levels of specificity
  - Social media to gather real-time sentiment
  - Google trends to decipher public interest and economic trends
  - Employee satisfaction on Glassdoor
  - Online invoices

- 89% of SAE's assets have outperformed their benchmarks over past 3 years net of fees, and 95% have outperformed over 10 years

**Fund Size:** $100 Billion

**Employees:**
- 80 FTEs
- 30 PhDs

BlackRock’s SAE arm outperforms its traditional stock pickers

% of assets under management above benchmarks (as of Dec 31 2017)

- Traditional equity unit
- Systematic Active Equities unit

**United Kingdom**

**California, USA**

Source: Autonomous NEXT, BlackRock, Financial Times, Reuters
Example of crowdsourced machine learning hedge fund using crypto tokens to reward 35,000 data scientists

**Overview**

- Numerai is a decentralised hedge fund that works by building its own financial model that incorporates the machine learning models submitted by data scientists from various backgrounds and expertise.
- The Numerai team democratises participation by making an encrypted dataset readily accessible via their platform.
- Data scientists download the dataset in order to build and submit their own machine learning model, targeting regions or sectors of the stock market in search of the best accuracy in predictability.
- Numerai synthesise all submitted models into their meta model, rewarding those with the most accurate predictive models in Numeraire—Numerai’s token.
- The diversity of models submitted leads to diversification in the meta model, reducing risk.

**Raised:** $7.5 Million

**Founded:** 2015

**Tournament Results**

<table>
<thead>
<tr>
<th>PARTICIPANTS</th>
<th>CONTROLLING CAPITAL</th>
<th>USD PAID OUT</th>
<th>NUMA PAID OUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>475</td>
<td>266</td>
<td>$3603.05</td>
<td>14412.09</td>
</tr>
</tbody>
</table>

**Data Scientists**

1. GRAS
2. THEAFH
3. STUDYAN
4. JOSEPH_SCHUMPETER
5. IRWAI
6. KARL_MARK
7. ANYTT
8. HENRY_WANG7
9. UWAEGE2
10. INTELEVAR

**Source:** Autonomous NEXT, Numerai / Medium
Example of an augmented investment analyst platform

Kensho

Overview

- Kensho Technologies is a company assisting in the scalable deployment of artificial intelligence, machine learning, natural language processing and data analytics systems to governments, global banks and investment institutions.

- Kensho uses natural language processing as well as machine learning to digest data stored in its Global Event Database - considered to be one of the world’s largest data repositories of unstructured data.

- Kensho’s service offerings include:
  - Financial Analytics Software: deploys scalable analytics systems across institutions.
  - Applied Mind: AI engine to process social and economic data across industries.
  - Koto: harnesses machine learning and natural language processing techniques to provide insight to governments and geopolitical analysts.

Acquired by S&P Global: $550 Million

Founded: 2013

Massachusetts, USA

Data Analytics

Natural Language Processing

AI / Machine Learning

Source: Autonomous NEXT, Kensho
Example of image recognition in insurance claims

- Tractable ingests large data set of photos of damaged car parts and associated claims estimates; machine learning creates associations between visual images and expected costs.
- Algorithm with UI can allow much faster claims processing – customer can take photo of damage and receive estimate in real time.
- Applicable to automated body shop adjustments, hail damage, roof inspection, and other use-cases.
- Instead of claimants, company drones can also perform the same task in the future.
- Difficult cases with low image recognition certainty can be directed to more specialized human service.

Source: Autonomous NEXT, Tractable
The Macro View on Intelligence Explosion
What’s next for AI-based financial products?

**Data profiling**
Baidu’s AI enabled user profiling

Baidu builds user portraits based on big data in 4 key distinct categories, 24 vertical fields and nearly 300 tags depicting interests, hobbies, habits and demands from multi-dimensions to profile their customers.

**Social Credit**
China’s dystopian citizen surveillance mechanism

China is testing a Social Credit System—a government initiative using an individual citizen’s social, financial and personal data to build a score which determines access to a multitude of public and private goods and services.

**DAOs**
Decentralized Autonomous Organizations pushing back

DAOs create organization hierarchies on the blockchain, allowing for governance to be enforced digitally through smart contracts. In recent years, DAOs have been set up at investment pools with digital and trustless means for transaction and investment.

**Baidu Financial Products**
(Wallet, Lending)

Access to Credit

Investments

Image Source: iStockPhoto, Ethereum.org
Exponential increase in computational power still holds, supported by development of powerful GPUs

Source: DFJ, Rodney Brooks
Exponential increase in open scientific research, including those in computer science and mathematics

- Launched in 1991
- Prestige of being included and cited in academic community
- Google, Facebook and Alibaba engineers contribute to this open knowledge base

Source: Nature, Cornell arXiv
American student interest in building artificial intelligence has sky-rocketed, as have the salaries for the field.

**Machine Learning Course Enrolment**

**AI Course Enrolment**

Source: AiIndex.org, New York Times
Path from narrow to general Artificial Intelligence, or at least virtual assistants, could be by narrow skill acquisition.

Amazon Alexa Skills

Google’s AI can create better machine-learning code than the researchers who made it.

No, Facebook Did Not Panic and Shut Down an AI Program That Was Getting Dangerously Smart.

Source: Statista, Business Insider, TNW, Tech Crunch, Open AI
AI skills need not be centralized at a tech giant or have proprietary code – they can be decentralized and open.

**Crypto Project Funded by $3.5 million ICO**

- Monetization between bots via a decentralized middle crypto token layer

**Stanford Mobile & Social Computing Research Group**

- Almond: The Architecture of an Open, Crowdsourced, Privacy-Preserving, Programmable Virtual Assistant

Source: Hut34, Stanford

Disclosure: Lex Sokolin has acted as an advisor to Hut34
China has invested into AI and has begun to outperform the United States on related academic research.

- Since 2014, China has seen 350 journal articles mentioning deep learning (vs. US at 260), and 80+ citations (vs US at 70+).
- Chinese Fintech companies, like Baidu and Alibaba, are global leaders in AI and are investing billions into development.

Source: 2016 National Artificial Intelligence R&D Strategic Plan

Alibaba to Spend $15 Billion Exploring 'Moonshot' Projects

By Lulu Yikun Chen
October 11, 2017, 3:28 AM GMT+1
Ethical and safety considerations are paramount

**Discrimination and Bias**

- Machine learning is trained on existing data, which reflects the ways that society and the economy are structured today.
- By replicating distributional results, AIs may perpetuate inequities and achieve outcomes that hurt minorities and protected classes.
- As an example, in a study of image recognition artificial intelligence systems, top three commercial software packages had an error rate of 0.8% when determining the gender of a light-skinned man, and a 20-24% error rate when analyzing pictures of dark-skinned women. Using such software for police work, for example, is a clear problem.
- Similarly, AIs used in credit underwriting may use thousands of data points, but then overweight items like Zipcode, which can correlate with income levels and ethnicity, prejudicing protected classes.
- We cannot only be mathematicians, but must also be social scientists designing kind systems.

**The Control Problem**

- Long term, a super-intelligent AI may be entirely indifferent to human needs and severely harm our interests, either on purpose or by unintended consequence.
- Aligning the utility function of such an AI in a with human requirements, i.e., building a friendly AI, is called the “Control Problem” and has challenged thinkers from Nick Bostrom to Stephen Hawking.
- The Machine Intelligence Research Institute was formed in 2000 to create the formal technical tools to help people prevent bad outcomes.
- OpenAI, another project focused on this problem, was founded by Elon Musk and Sam Altman in 2015, and is backed by $1 billion in pledges.

Source: MIT, American Banker, OpenAI, MIRI, Icons via Rouncicons from www.flaticon.com
About Autonomous
Autonomous NEXT is a mission-driven innovation and fintech research process for financial firms and investors

- We are independent, creative and original thinkers about the future of finance serving the world’s largest financial services investors
- We combine both a fundamental and innovation perspective
- Better decisions in financial services = better outcomes for real people
We are a global financial research firm ...

Autonomous is a partnership, fully owned by its people, with no external investors.

The founding partners of Autonomous were top ranked for 5 years in the European banking and insurance sectors (ex ML and Citi).

Autonomous covers 196 companies globally, with a combined market capitalisation of $4.4 trillion.

Autonomous offers exclusivity/limited distribution to provide a more bespoke service.

Our objective is to be the leading global research firm for financials.

Our strategy is to be the trusted advisor to the world’s leading asset managers.

Autonomous has 90 people globally including 40 full time analysts with unrivalled experience covering banks, insurers, diversified financials and FinTech.

Autonomous offers unique and unbiased perspectives on the future of Fintech by exploring the way in which technology will shape the global financials industry.
… that combines an entrepreneurial and fundamental view

Lex Sokolin
Global Director Fintech Strategy

Lex is a futurist and entrepreneur focused on the next generation of financial services. He directs Fintech Strategy at Autonomous Research, a global research firm for the financial sector, helping clients understand and leverage innovation.

Lex is on the Board of Directors and previously was the Chief Operating Office at AdvisorEngine (formerly Vanare), a digital wealth management technology platform that received a $25mm investment from Wisdom Tree. He was also founder and CEO of NestEgg Wealth, a roboadvisor that pioneered online wealth management in partnership with financial advisors, acquired by AdvisorEngine.

Lex is a contributor of thought leadership to the Economist, the WSJ, CNBC, Reuters, Investopedia, American Banker, ThinkAdvisor, and Investment News, among others. He has spoken on the future of technology and achieving extraordinary growth at conferences for Money2020, LendIt, Techonomy, In|Vest, T3 Enterprise Edition, and the FPA.

Prior to NestEgg, Lex held a variety of roles in investment management and banking at Barclays, Lehman Brothers and Deutsche Bank. He holds a JD/MBA from Columbia University and a B.A. in Economics and Law from Amherst College.
Our thought leadership in Fintech has practical implications for financial services companies, tech firms and startups.

The new funding mechanism using distributed ledger technology that displaces both public markets (IPOs) and private investment with $ billion of Cryptocurrency

Making sense of blockchain, digital currencies, roboadvisors, wealthtech and other futurist themes within a unified, quantified framework

A blueprint for the strategic roles and competitive options of financial services, high-tech and start-up companies in 2030

We see clearing and settlement as the first major implementation. Blockchain can reduce industry spend by 30% or $16bn on a five year view.

We expect digital lending to double again before 2020, reaching $100bn in loan origination volumes from the US and Europe combined.

We see 2025 as the point when fully autonomous cars become a commercial reality. We see motor premiums in the developed world more than halving between 2025-40.

Source: Autonomous NEXT
Autonomous Research is a leader in equity research on financial services, translating themes into investment ideas.
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