The New Wave of Artificial Intelligence

EVRY

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Foreword

In this research paper we will explore the current wave of A.I. technologies and A.I. businesses. We will start off with our main hypothesis of why A.I. is different this time. This is followed by a quick survey of the emerging A.I. economy where we will look at examples of companies leveraging this new technology to disrupt existing industries and create new ones. This will hopefully give the reader some feeling of what kind of applications A.I. is used for today.

1 INTRODUCTION

We are living in the midst of a surge of interest and research into Artificial Intelligence (hereby A.I.). It can seem like every week there is a new breakthrough in the field and a new record set in some task previously done by humans. Not too long ago, A.I. seemed a distant dream for especially interested researchers. Today it is all around us. We carry it in our pockets, it's in our cars and in many of the web services we use throughout the day. As this technology matures, every business must ask itself the central question: how will this disrupt my industry? Throughout this research paper, we will investigate the possible implications of the rise of A.I. on the banking industry.

What is Artificial Intelligence?

If we ask Wikipedia; Artificial Intelligence (AI) is "the intelligence exhibited by machines or software. It is also the name of the academic field of study which studies how to create computers and computer software that are capable of intelligent behavior". While this seems like a reasonable definition, a lot of people struggle with identifying the difference between AI and ordinary software. This is a fair point, as there is no clear line

No easy definition of what is AI and what is just normal IT.

between the two concepts. For the purpose of this paper, it is best to avoid the technical definitions used by academics in the field, and instead think of AI technology as the sort of technology you would use to do tasks that require some level of intelligence to accomplish. With the added feature that AI systems often are the kind of systems deployed in domains where there is a lot of uncertainty. The simplest example of this is a chess computer vs. a calculator. Both chess and arithmetic requires some level of intelligence, but whereas in chess there is a lot of uncertainty with regards to the opponents next move, the routine calculations performed by a calculator contains no uncertainty.

The only thing you need to know about A.I.

This is not the first period of massive public interest in A.I. In fact, A.I.'s long history of being "The Next Big Thing" has led the current top researchers in the field to publicly downplay their findings, in order to avoid the hype getting out of hand. Ever since the start of the field, the long term goal of A.I. research has been what is called *Strong A.I.*, a computerized brain capable of doing every intelligence task that a human can perform. Roughly every decade since the 1950's, promises have

A.I has followed a classic boom and bust cycle ever since.

been made about the impending arrival of *Strong A.I.*, and every time these promises were broken, all the funding for A.I. research dried up in what the industry calls "A.I. Winters".

This brings us to one of the main points of this research paper. We are now at a point where the disruptive force of A.I. technology no longer hinges on whether or not *Strong A.I.* is ever achieved. The only thing you as a business person need to know about A.I. is this: the technology has now matured to a level where it, regardless of future progress in the field, is set to disrupt almost any technology based industry. The reasons for this will be explained in the following sections.

Figure 1: A chess board.

2 WHY A.I. IS DIFFERENT THIS TIME

It is a saying in finance that the most expensive four words in the English language is "This time it's different". The saying is meant to imprint caution in the mind of people looking to invest in hyped assets with a history of disappointment. Given the history of A.I., one might do well to keep this in mind. However, is it possible to find any justification for why it is, in fact, different this time? Kevin Kelly, the founding executive editor of Wired, lists the following three reasons.

The decreasing cost of computing power

Thinking, for all practical purposes, is computation. And in order to simulate a system that is even remotely intelligent, a great number of computations are needed. Moore's law, which says that the number of transistors on integrated circuits double roughly every two years, has provided growing computational capacity for the last five decades. But this is not enough. Luckily, it was discovered during the last decade that GPUs, the chips used for generating computer graphics in video games etc., were eminently suited to run the sort of massive parallel computations needed for building A.I. architecture. In practical terms, this has meant that

Google, Facebook, Baidu etc. are hiring all the A.I. experts they can get their hands on

calculations that used to take up to several weeks, now take less then a day, and the time is shrinking. Building intelligent applications would simply not be possible without the increase in cheap, available computing power that we have been fortunate to witness the last decades.

The availability of data

It is no coincidence that the recent intense interest in A.I. from the tech industry comes right after Big Data became a household word. The by far biggest investors in A.I. technology are Facebook, Google, Yahoo, Baidu and Microsoft. They have hired almost all the leading researchers in the field and setup their own research labs

Several breakthroughs in algorithms for machine learning during the last decade.

internally. The common denominator for these companies is that they sit on truly massive amounts of data that they need to analyze. A.I. bears the promise of an automatic analysis and management of this data,

which is what these companies are looking for. There is an interesting symbiosis between A.I. research and data: Just like the brain of a child, an A.I. system needs huge amounts of information in order to *learn*. And companies who sit on huge amounts of information usually wants to minimize the human effort of analyzing this data. This relationship is bound to fuel the development of A.I. going forward. A nice example of this is IBM's Watson engine. Watson is a distributed cognitive system, meaning that it is spread out in the cloud, collecting information every time it's being used, everywhere. This means that the more people use Watson, the better the system becomes at it's job.

Better algorithms

A new type of algorithms lies at the heart of this new A.I. wave and it's safe to say that without these, the data and computing power would amount to nothing. It might come as a surprise that it is all based on technology from the 50's, called Artificial Neural Networks (ANN), which is an attempt to model the network of nerve cells in a human brain on a computer. Loosely speaking, it is a interconnected web of artificial neurons that either fire or not based on what the input to the neuron is. A key part of building these neural networks, is to be able to train them to do the correct thing when they see data. Even though this technology is as old as the field of A.I. itself, it was not until recently (2007) that we had the algorithms to train truly big networks that could solve more interesting problems. The study of these algorithms has now spawned its own sub-field of A.I. known as Deep Learning, its name referencing the number of neuron layers in the neural networks.
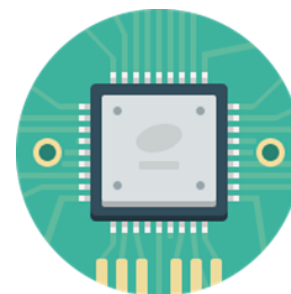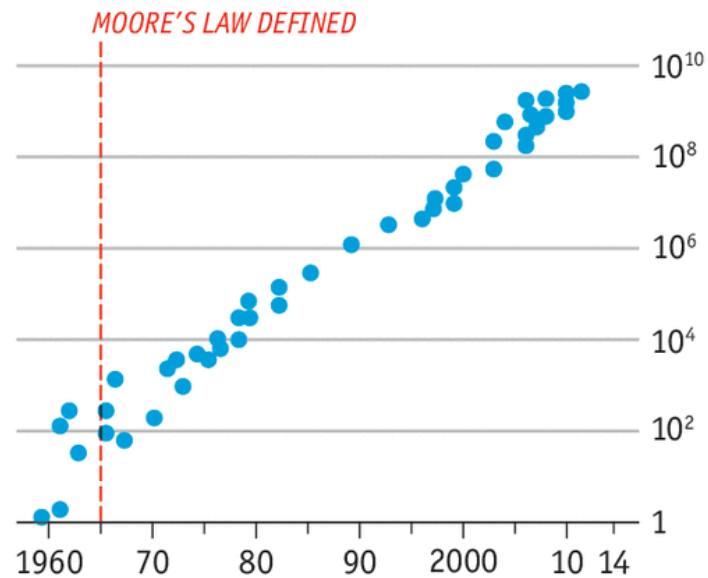

Moore's law has not yet failed, and innovations have been made in utilizing graphics processors.

A persevering prediction

Number of transistors in CPU*

Log scale

MOORE'S LAW DEFINED

	10^{10}
	10^{8}
	10^{6}
	10^{4}
	10^{2}
	1

1960 70 80 90 2000 10 14

Source: Intel   *Central processing unit

Figure 2: Moore's law.

Conclusion

The combination of the three factors outlined above have laid the ground for a wealth of consumer and business facing applications, most of which we have not yet seen. There exists a big gap between where businesses could be and where they are in terms of building internal competency with, and implementing, this technology. It is precisely because of this gap that we maintain the hypothesis that the disruptive force of A.I. is almost completely independent of the future progression of the field. It has already arrived.

3 WHAT IS INTELLIGENCE

The field of A.I. can seem quite daunting for non-specialists and part of the reason for this is because the way we think about intelligence has changed during the last couple of decades. *This has had the result that it can be very hard for non-experts to understand what this technology can be used for*. As will be explained in this section, it's all about changing how one thinks about intelligence.

In the beginning of the field of A.I.'s existence, one thought that the way to approach it was to instill a computer with logical 'rules' that would result in rational behavior, and then populate this computer with facts about the world in a big "Knowledge Table". This approach was later shown to be doomed to fail. Manually typing in facts about the world, and hoping that strict rules would help the computer understand the relations between these facts, becomes exponentially cumbersome as you add more facts.

General A.I. would have a human or superhuman level of intelligence

A specialist A.I. can drive a car or play chess, not very good outside it's domain.

Emergence

The fact is that we do not really understand what intelligence is or where it comes from. This goes for not only the artificial kind, but also our innate intelligence. One reason for this problem is the many different definitions of intelligence. However, there have been some developments 'lately'. Science has throughout the last decades increasingly adopted the view of intelligence as an emergent property of some complex systems. That means that the aggregate behavior of very simple parts of certain complex systems lead to intelligent behavior. The part of you or the people you know that is responsible for what can be called

intelligent behavior is in reality a finely tuned network of very simple parts. This view of intelligence as the behavior of simple parts in a complex system has some interesting consequences, because it has led to scientists finding what fits this definition of intelligence in surprising places. For example, a single termite is not especially smart. One might even go so far as to call it stupid. But a termite colony exhibits intelligent behavior in the sense that it builds complex structures to live in, which even has built-in fungus farms for food supply. This type of behavior can be seen many places in the insect world: the aggregate behavior of "simple" insects is surprisingly complex and adaptive to changes in the colony's environment. The effectiveness of the bugs' methods has not been lost on the people in computer science. There is now an entire class of algorithms known as Swarm Intelligence algorithms that attempt to solve problems in this decentralized, self-organizing way.
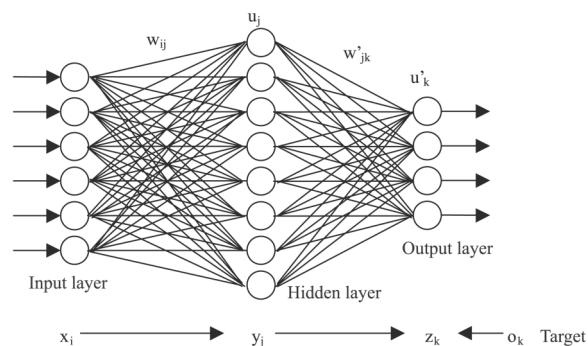
Figure 3: Example architecture of a Artificial Neural Network

What Emergence means for A.I.

This whole new wave of artificial intelligence research and technology really hinges on this "emergence-view" of intelligence being a useful way to analyze intelligent systems. The reason for this is that if intelligence is not an emergent phenomenon, then humans will have to build intelligent systems from scratch. That is simply not feasible. So this is why most modern A.I. systems are built with the purpose of self-learning through emergent complex behavior of simple parts. The most common example of this is Artificial Neural Networks (see Figure 3 on next page for an illustration).

Each node in a network like the one in Figure 3 is simply a function that either outputs a 1 or a 0 based on its input from other neurons. But with enough of these neurons stacked in layers one after another, and with enough training data, a network somewhat like this can be taught to recognize faces and other objects in pictures. One of the more impressive examples of this is a system by Google (Figure 4) that can automatically caption images. It does this by using one neural network to attempt to recognize all the important objects in the picture, then it uses a second neural network to generate sentences about the relationship between these objects. What these examples show is that the correct set of algorithms, with the correct training can learn to distinguish signal from noise in a way that is meaningful to humans. *The fact that the input data in these examples are pictures is irrelevant*. This begs the question of what we will be able to build with systems whose sensory input consists entirely of say bank customer data, transaction data including fraud cases, stock prices and so on. These are the questions that some of the companies in the next section attempt to answer.
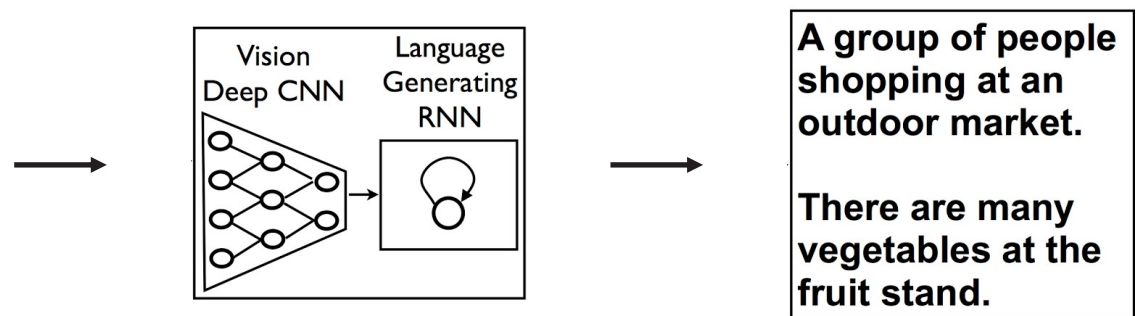
Figure 4: The automatic captioning system recognizes objects in photographs and then tries to choose a sentence that explains the scene.

4 THE EMERGING A.I. ECONOMY

Talk of artificial intelligence often creates images of HAL9000 from *2001: A Space Odyssey* or Skynet from the *Terminator* movies. This is only natural, as Hollywood for a long time has been one of the main providers of futuristic visions to the public. However, to get a more realistic picture of how this technology will affect the world around us, it probably makes more sense to study the business models of the companies trying to build this future right now. In the following sections, we will have a look at the technology landscape of the Machine Intelligence industry, and look at companies that are using A.I. to deliver services in a way that might surprise you.

The Machine Intelligence business landscape

A good way to get a feel for an up-and-coming technology industry is to build what is called a *technology landscape*. A technology landscape is nothing more than a big picture with a lot of company logos on it, where the companies are segmented by the problem they are trying to address or value they want to offer. In 2014, a Venture Capitalist at Bloomberg Beta

"Whoever wins AI, wins the internet" – Andrew Ng, Chief Data Scientist at Baidu.

named Shivon Zilis spent three months building just such a technology landscape for what she calls the machine intelligence sector (Shown in a too small picture in Figure 5). She built a list of over 2 500 A.I. or machine learning related companies and start-ups and narrowed it down to what you see in Figure 5. The landscape is sliced nicely into the following segments, which we will go through in turn: Core Technologies, Rethinking Enterprise, Rethinking Industries, Rethinking Humans/HCI and Supporting Technologies.
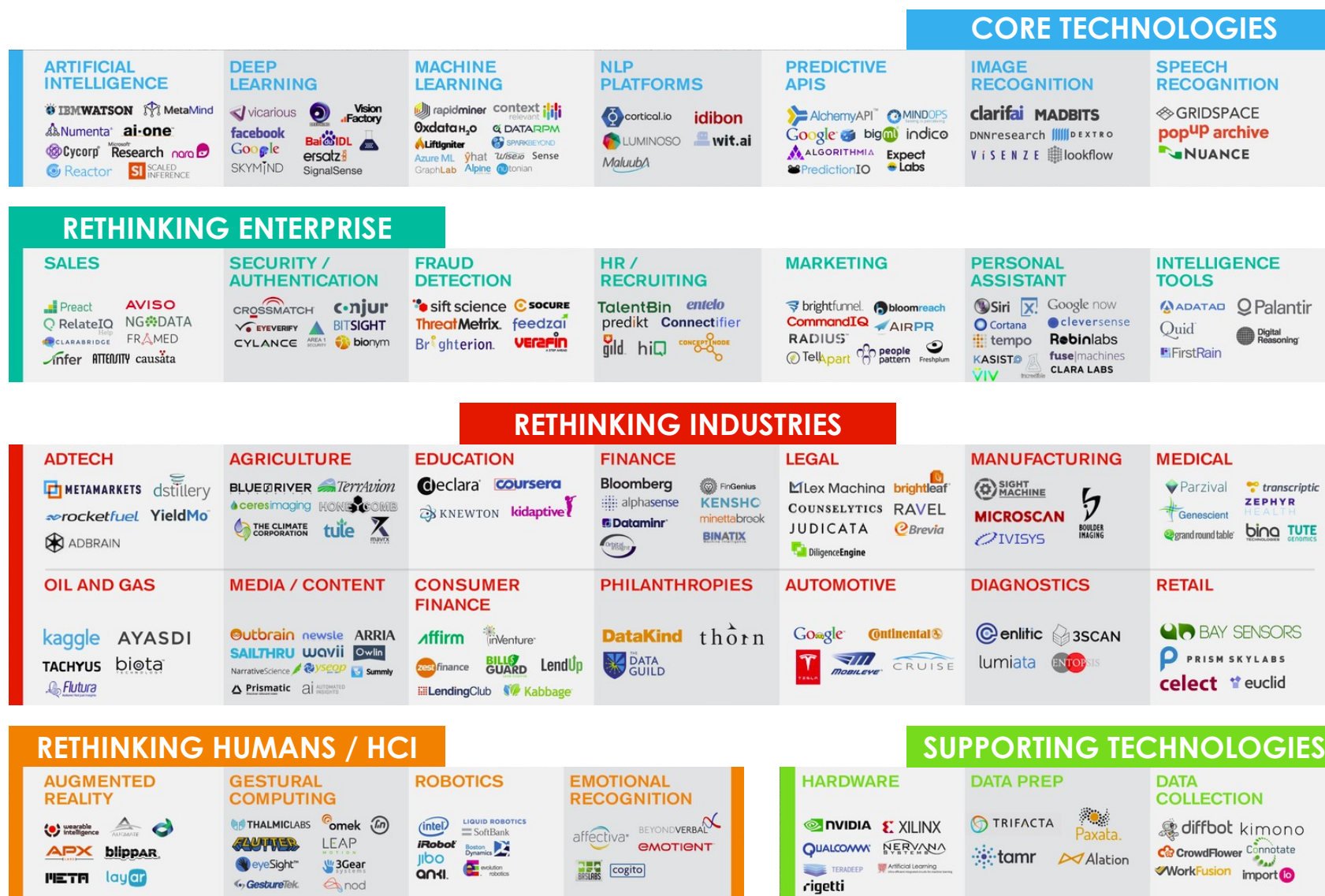
Figure 5: The Machine Intelligence Landscape, by Shivon Zilis.

CORE TECHNOLOGIES

The companies in the Core Technologies segment are the ones working directly with advancing the A.I. and Machine Learning fields. They range from technology providers to other A.I. driven companies, to companies providing advanced analytics products directly to the end user.

RETHINKING ENTERPRISES

This segment contains the companies attempting to leverage machine intelligence in order to build smarter enterprise solutions for companies in general. Examples of this range from advanced churn prediction software, that can alert sale teams that a customer is growing dissatisfied (Preakt), to smart fraud detection, that analyzes fraud in real-time using over 5 000 signals (Sift Science).

RETHINKING INDUSTRIES

The Rethinking Industries segment is composed of companies using A.I. to change the way things are done in existing industries. It is here you will find many of the more "sexy" A.I. start-ups. Among them, we have

Knewton, which aims to deliver personalized education to every student, Lex Machina, which offers an analytics engine that lawyers can use to search for similar cases, relevant laws etc., and many others.

RETHINKING HUMANS/ HCI

This is the wild card category containing the more sci-fi like companies. Here you will find companies attempting to make computers understand human emotions and designers of various *augmented reality* products.

SUPPORTING TECHNOLOGIES

The companies in this segment offer products or services that enable the companies in the other segments to do their thing. This ranges from chip makers, to providers of user friendly software for web-scraping and other information gathering. Among the more exciting and ambitious projects in this segment, we have HP and IBM's attempts to rethink the way we do computing by designing what is called *neuromorphic* (brainlike) hardware.

A glimpse at some innovative companies

In order to get a better feeling for how A.I. is driving new types of businesses, we will take a more thorough look at some of the companies from the landscape.

Deepmind, Numenta, Vicarious

For the purpose of this research paper, these companies are so similar that we might as well bundle them together. All three companies are trying to solve the *Strong A.I.* problem, and all three are backed by titans of the Tech industry: Deepmind is backed by Google, Vicarious by Mark Zuckerberg and Elon Musk, and Numenta by Palm Computing founder Jeff Hawkins. While all three companies have examples of applications for their products, they more resemble private sector research labs than conventional companies.

But these companies are not interesting because of their products' immediate applications, but because they represent the front line in an ever-intensifying arms race in Silicon Valley. As put by Andrew Ng of Stanford and Chinese search giant Baidu, "Whoever wins A.I., wins the

These three companies are chasing "Strong AI". No focus on short term rewards or commercial application. Biggest disruptive potential.

internet". These companies mark an interesting shift in the development of core A.I. technology. The technology used to drive the current generation of A.I. applications was usually conceived at academic institutions and then later adopted by corporates. Now, we have a situation where the tech giants have placed a large number of the industry's experts in their internal laboratories, which might lead to less openness about technical breakthroughs going forward.

VIV - The Global Brain

VIV is the brainchild of the original team behind Apple's A.I. assistant Siri. Siri is one of the first examples of an A.I. helper that the the public actually has appreciated (remember Microsoft's Office Assistant paperclip?). She could search the web for you, send texts, set alarms and even had a sense of humor. The creators however, felt that the project had stopped short of what was possible. So right after the death of Steve Jobs, they left Apple to set up VIV Labs, where they are now hatching their next creation. Their ambition for VIV is to create a truly generalist A.I. assistant for all platforms. They have designed it around three principles: It will be taught by the world, it will know more than it is taught and it will learn something new every day. That means that if it helps you solving a problem after some trial and error, then that solution becomes available for every other user that encounters the same problem afterwards. Having VIV help you find a suitable wine for lasagna on your way to your friend's house is one of their more impressive examples. VIV is a good example of the companies that believe that a lot of people will in the near future interface with some form of machine


The Grid is an example of a specialized "servant AI". Designed to do work humans find boring.

intelligence instead of using e.g. web browsers when carrying out tasks like buying airplane tickets. As the technology becomes less visible and more human-like in its capabilities, it becomes easier to use for everyone.

The Grid

The founder of The Grid, Dan Tocchini, used to work as a website designer. After a couple of years in the industry, he began to find the tasks menial and repetitive. Every time a business is changing something about itself, offering a new product, entering new markets etc. that change needs to be reflected in the website. This usually

means that a person needs to do the painstaking work of changing the design of the website to reflect the change in the business. Enter The Grid. The Grid is designed to be a A.I. driven website builder. Users
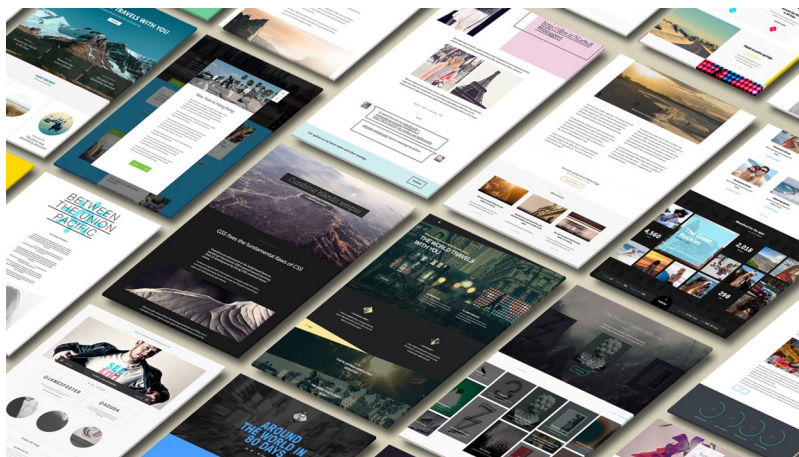
upload raw content in the form of text, pictures and other media. Then they specify the purpose of the website, be it business, social or some other type. After that, The Grid's engine takes care of the rest and compiles your input into a working website designed to achieve what the web-site's owner wants, e.g. promoting higher sales or new customers.

The Grid represents the type of companies that want to alleviate the load of performing certain types of work by using A.I. instead of outsourcing. For example, instead of having a call center in an offshore location, a company can have a call center at home manned by artificial intelligence agents. This is a phenomenon that is bound to become more and more prevalent as the range of tasks that A.I. agents can perform continues to grow.

Summary

The companies shown in this small selection illustrate the breadth of this emerging industry. And that breadth is one of the key things one needs to understand about the ambitions of this field. The vision for the people behind VIV and a large part of the A.I. crowd is that this technology will be like a utility in the future. Much like we now use electricity or water to solve problems, the hope is that intelligent computation will be a general resource in the same way. This way of looking at intelligent computation really broadens the scope of what one can imagine using this technology for.

5   A.I. IN BANKING

The purpose of the preceding sections is to get the reader thinking about how the technologies surveyed could be tweaked and applied to banking. One problem of technology with broad applications is that it can be hard to know where to start applying it. Another question is the maturity of the technology across application areas.

Wealth Management for the masses

One of the banking areas that have seen a lot of investment in machine intelligence is wealth management. Both incumbents and newcomers are realizing that the digital shift that is happening in banking will affect this sector. UBS, a Swiss heavy-weight in the wealth management business, recently acquired a seven year old startup called Sqreem after it held an innovation competition that Sqreem won. Sqreem's forté is automatic analysis of large amounts of unstructured data with the purpose of detecting "typical" behavioral patterns. UBS's hope is that this engine will can offer insights in how to best service their high-net-worth clients.

Perhaps even more interesting is the arrival of Wealthfront and Betterment. By automating large parts of the wealth management process, they are able to offer personalized, tax optimized investments to clients who have far less in investable assets than what would usually qualify for professional wealth management. Wealthfront have an minimum account size of $ 5000 and Betterment has no minimum account size. Both companies' approach is based on asking the user questions about their financial goals, financial status etc., and from this deduce the optimal asset mix for the client using analytics.

New entrants are using automation to cut the costs of offering wealth management services.

Customer support/help desk

This isn't really a banking specific area, but as it applies to banking I will include it here. Everyone hates being "next in line" on some phone call when all they want is just to have their online bank work etc. As speech processing and natural language processing technologies mature, we are closing in on the day where computers can handle most customer service questions for us. This would mean an end to the waiting in line, and happier customers.

Advanced Analytics

Another area which has seen a lot of investment are is the use of machine intelligence for advanced analytics. An example of this is the young company Kensho, which just received $ 15 million in funding from Goldman Sachs. Kensho has built a natural language search engine capable of answering questions like "What happens to stocks when inflation falls below 2 % and GDP growth is flat" or "Which stocks to buy when the oil price falls". While this does not seem like an application of immediate importance for retail banking it's a good example of how companies are trying to make

advanced analytics more user friendly, in essence turning business analysts into potential data scientists capable of performing sophisticated querying against available datasets. This is the explicit goal of Sensai, another machine intelligence startup. They offer a platform that will make it easier to collate data from different sources. As Banking is one of the worlds most data-intensive industries, and becoming ever more so, the capability to actually analyze all this data will be of growing importance.

KENSHO   **sensai**

A new generation of intelligent analytics companies address infrastructure concerns raised by the arrival of Big Data.

Fraud Detection

Most industries operating on the world wide web are susceptible to fraudulent users, and banking is no exception. As technological infrastructure grows more complex, so do the demands on those protecting companies and people from fraud. Marc Goodman, author of "Future Crimes" explains in his book that criminals are often the first to exploit emergent technologies and turn their complexity against their users. This has led to an arms race between online security providers and fraudsters involved in everything from email scams to credit card fraud. As security providers improve, the criminals change their ways. This moving target calls for platforms that can learn to identify changing patterns of fraud, which is what companies like Feedzai and SiftScience is trying to do. By tracking thousands of signals in real time and sharing information across their network of clients they are able to help their customers catch over 89 % of fraud cases while reviewing only 1 % of customer orders. While SiftScience doesn't seem to have any banking clients at the moment, this way of thinking and doing fraud detection is bound to spread to banks very soon.

Feedzai and SiftScience are helping their customers catch over 89 % of fraud cases while reviewing only 1 % of customer orders.

Underwriting

The newcomers in the underwriting business, like Zest Finance, really cut to the heart of the business of banking. Using as much data as they can get their hands on, in combination with advanced machine learning algorithms, they are able to more effectively price personal credit risk. Their business model is based on helping lenders in different credit segments by assessing their clients for them, and according to them their Big Data model is a 40 % improvement over the best-in-class industry score. One of Zest finance's philosophies is "All data is credit data". That means that they track everything they legally can about the user, to identify what interest rate he should pay. This includes, browser type, device, location, time, how long you

Over 2500 startups have Artificial Intelligence as a core part of their business model.

spend reading the conditions of the loan etc. The results achieved by Zest Finance and their peers' algorithms imply that companies which fail to implement this type of thinking in their organization will eventually be faced with a massive competitive disadvantage.

Steps forward

Banks in general are under threat by fintechs. A big reason for this is the extent to which tech-startups embrace the emerging AI technologies and leverage them to outperform banks at their own game. The good news for banks is that none of what these fintech companies do is magic, it is simply new technology, most of which can be bought, and some of it is even free. By building internal competencies in the field of data science and machine learning, banks can adopt the same AI tools currently used by fintechs. Take for example the wealth management companies like Wealthfront and Betterment. Building a solution like that for a Norwegian bank is more than doable. But that takes commitment from a high level in the organization, and a realization that properly understanding the data you have is growing in importance every single day.

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Blockchain: Powering the Internet of Value

Blockchain is poised to become a massive disruptor for the financial world. This paper describes the technology, how it will alter the financial world, and a recommended strategy for financial institutions.

The New Wave of Artificial Intelligence

Artificial Intelligence is becoming increasingly prevalent in our everyday lives. This paper investigates the possible implications of the rise of Artificial Intelligence in the banking industry.

Big Data in banking

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We bring information to life