Investment Spotlight   First Quarter 2020

Each quarter we highlight an investment theme from the Disruptive Innovation Strategy, focusing on the megatrends driving disruption and the companies we believe are best positioned to capitalize.
Companies mentioned in this series should not be perceived as specific stock recommendations.

Machine Learning (ML) & Artificial Intelligence (AI)

Introduction

Machine Learning (ML) and Artificial Intelligence (AI) are on the precipice of wide-scale adoption in many industries, thanks to the reduction in the cost of cloud-computing and advances in data science. As the reliance on ML and AI grow, however, questions are being asked which are as old as computing itself: Can computers be trusted? Can they learn from us, and could they one day take control of our lives? In the 1960s, these questions were raised in Stanley Kubrick's 2001: A Space Odyssey, which featured the malevolent AI character, HAL 9000. Today these questions are being asked of the largest technology companies, such as Google, Facebook and Apple that collect vast amounts of our personal data without our knowledge or explicit consent.

The relative immaturity of ML/AI has led to algorithms being optimized purely for business goals, such as the likelihood of a consumer making a purchase after seeing an ad. To date, the ability for AI to establish context and apply judgement has been limited by technology, which we believe has contributed to its misuse. It is also fair to say that regulators have not kept pace with advances in AI. Recent breakthroughs in Natural Language Processing (NLP), Deep Neural Networks (DNN), and semiconductors designed to mimic neural pathways will soon power the next-generation of AI, and go a long way towards introducing these capabilities. In the near future, with sensible regulation, we believe AI will become an essential tool with which to address societal problems like "fake news", "filter bubbles" and voter manipulation, and ultimately will be seen as a major contributor to economic productivity.

Regulation

In an age of partisan politics, one issue both parties agree upon is the need for greater regulation around privacy, in order to prevent violation of the implicit trust users extend when they share personal information. Users enjoy free web services, and the productivity gains from tailored recommendations, but they don't appreciate that information being shared, sold, or used for purposes to which they are opposed.

In recent months, technology companies have called for clear guidelines and regulations in privacy-related matters. The most recent legislation, the General Data Protection Regulation (GDPR) in Europe, and the California Consumer Privacy Act (CCPA), are promising. In addition, Google publicly supports the OECD's framework on data privacy[1], and recently published its five key principles on "ethical AI", which include recommended practices and views on fairness, interpretability, privacy and security[2]. Google's CEO, Sundar Pichai, stated recently that he considers AI to be among the most important inventions since fire and electricity. The long-term interests of regulators and private enterprise are aligned when it comes to AI, so we remain optimistic that a sensible regulatory framework will develop.

Investments

In the 1919ic Disruptive Innovation Strategy, we have invested in four companies we believe will benefit from advances in ML and AI, including Alphabet (Google), Facebook, Yandex, and NVidia. In the case of Google, Facebook and Yandex, ML/AI are tools which support advertising-related business, while NVidia is a semiconductor company supplying state-of-the art computing hardware for ML/AI. All four are disrupting their respective industries and are outpacing regulators, which means the debate over the role of ML/AI likely will continue.

Google

When Sergey Brin and Larry Page published their seminal paper about a new type of search engine, called Google[3], their description didn't include Artificial Intelligence as it is understood today. Their algorithm, PageRank, looked at how web pages were linked to one another, and ranked them from most popular to least, based on the number of *hyperlinks.* In effect, it was a statistical measure that relied on a crowdsourcing-type mechanism to gauge popularity. It used keyword searches to deliver web pages, but without an understanding of the *context* of what was sent, or the *intent* of the author. As Google's search

algorithm advanced, it incorporated additional points of data, or "signals" to improve its PageRank algorithm, and continued to rely on statistical measures to optimize results, but it was far from being able to read minds or apply moral judgement. It was simply a highly-optimized tool designed to deliver information quickly. Initially, what made Google a great search engine was that the PageRank algorithm could *scale*, which was crucial during the early days of the web. What makes Google the dominant search engine today is its ability to leverage hyperscale infrastructure to collect and analyze thousands of signals from across the web to respond to search queries in microseconds, and with *meaningful* content.

Ultimately, Google makes money when users click on ads shown on its search engine, on YouTube and other Google-owned properties, or on ads it serves up on third-party sites. The most effective way to do that is to deliver the right ad, at the right time, to the right person. But consumers don't visit Google sites because of the ads, they visit because the web services offered by Google are among the very best. Nine of these services attract over one billion visitors each on a daily basis[4], supplying the raw data to improve Google's search algorithm. Today, Google's parent company, Alphabet, spends $25 billion per year on capital expenditures, which is more than Verizon, AT&T and nearly twice as much as Intel, to support a $150 billion business that is driven mostly by search. Despite being one of the world's largest companies, with a market cap of about $1 trillion, it continues to grow revenue in the 20% range[5] on the strength of its highly-evolved search algorithms and adjacent services.

The level of resources available to Google employees has attracted world-class talent, which in turn has led to many breakthroughs in computer science, particularly in the field of AI. In 2018, Geoffrey Hinton, from Google Research was one of three researchers given the Turing Award for foundational work in Deep Neural Networks (DNNs), an award considered to be the "Nobel Prize" of Computer Science. DNNs are among the most important machine-learning algorithms and

are used extensively in robotics, speech and image recognition, and in autonomous driving. In 2018, Google published breakthrough research on Natural Language Processing (NLP) using DNNs which allowed a computer to have a *general understanding*[6] of words it had never seen. Today, only a handful of companies can take on NLP at scale. Google is offering its NLP model, called BERT[7], as a service through the Google Compute Engine (GCE), which supports DNN computing. NLP is important for Google since 15% of the search queries it processes have never been seen before. As it expands into adjacent areas, including autonomous driving with Waymo and home automation with Google Nest, the opportunities to accumulate contextual data will increase, as will the need to process data in a socially-acceptable and legal manner.

Facebook

Facebook came of age during the second wave of internet companies with a business model built on user-generated content and relationships among its members. Its business model, much like Google's, was to sell ads on its website. Instead of focusing on access to information through search, however, Facebook served up ads based on a user's *interests,* making it an ideal laboratory to develop AI for the purposes of behavioral targeting.

Facebook began as a way for college students to stay connected, but it soon morphed into a version of today's mission statement to "give people the power to build community and bring the world closer together"[8]. Its monthly active-user base has grown to an astounding 2.5 billion people in 15 years, or about 40% of the global population ex-China[9]. People clearly find the service useful, and the extent of information shared on Facebook today is unparalleled. No other site has the combined scale, level of engagement or global footprint of Facebook.

Facebook has been highly effective at leveraging its footprint and data to build a $70 billion advertising business, growing 30%+ YoY[10], with nearly 50% pre-tax margins. However, it is fair to say that the

pre-2014 motto of "move fast and break things" has come back to haunt the company, most notably in the Cambridge Analytica scandal of 2017, in which Cambridge Analytica sold user profile data for election-targeting purposes, in violation of Facebook's policy. Facebook paid a record-setting $5 billion fine to settle the matter, and today employs over 35,000 people in data security.

The company has also made great strides in AI research, with Facebook researcher Yan LeCun sharing the 2018 Turing Award mentioned earlier. As with Google, high levels of compensation and world-class infrastructure have attracted the best and brightest, and its scientists see compelling opportunities to make breakthrough discoveries. At Facebook, state of the art AI is beginning to be used to flag objectionable content in near real-time, which is a monumental undertaking given that its user base is nearly twice population of India. It is too early to tell whether this will slow the spread of fake news or dampen criticism of its platform, but it likely will over time. What remains clear, however, is that Facebook's platform remains invaluable to its users and advertisers, and the impact of the Cambridge Analytical scandal has left a deep impression on management. We remain investors because we are comfortable with the changes that have taken place at Facebook, and we believe the company is well-positioned to benefit from using ML and AI in future areas, such as augmented and virtual reality.

Yandex

Yandex is often referred to as the "Google of Russia" due to its focus on search, mobile applications and research on businesses to which it refers as "other bets", a term adopted from Google's parent, Alphabet. Yandex was founded by serial tech entrepreneur Arkady Volozh in 1997, a year before Google, and has competed with Google in areas of search, maps and other AI-related fields. The company has a market cap of $14 billion, is listed on the US-based NASDAQ exchange, incorporated in the Netherlands, and is the largest technology company in Russia. A risk in investing in any Russian company is that government

influence could disrupt the business and impair the value of the company. That risk has surfaced from time-to-time for Yandex, including recent efforts to limit foreign ownership of the company's stock. As with major tech platforms in the US and China, Yandex has been able to find a workable solution because of the contributions it has made toward building a digital economy in Russia, which is clearly recognized, valued and supported by the Kremlin[11].

Yandex has been successful at holding Google at bay in Russia due to its grasp of the nuances of the Russian language, allowing it to dominate search, maps, digital assistants and, more recently, social media. The bulk of revenues and profits come from digital advertising based on search in Russia and Europe, where it generates $2.5 billion in sales (2019) that are growing 35% annually, with 25% pre-tax margins. Russia has a population of 145 million people, but internet penetration is relatively low, at 70%, vs. 90% for the US and Western Europe. It has ample room to grow its core advertising business, and, with further developments in AI, is well-positioned to expand into adjacent areas. As with Google and Facebook, Yandex has invested in AI research to support adjacent businesses, including Yandex taxi, which is one of the world's largest, and seemingly only profitable ride-hailing service. Yandex taxi operates in over 300 cities in Russia/CIS, the Middle East, Europe and Africa, but is a relatively small part of Yandex, representing only 5% of total annual revenue. Like its larger peers, Uber and Lyft, it has plans for an autonomous robo-taxi service where it can leverage its competitive strengths in maps, search and AI.

NVidia

NVidia is the world's leading graphics chip company that has successfully diversified its business from selling graphics cards to PC gamers to selling Graphics Processing Unit (GPU) accelerators to cloud companies researching AI. Graphics chips, among the most complex semiconductors, are used to train computers to recognize certain patterns and from there, to identify or *infer* new objects or patterns. NVidia

serves a wide range of ML/AI applications. For example, it has developed a platform for autonomous vehicles called DRIVE, which includes the Pegasus platform for training, and the Xavier platform for inference. Training refers to using large amounts of diverse data in an AI system to get a particular outcome. For autonomous driving, that would include simulating the operation of a car in millions of different scenarios, training it to identify objects, and obey traffic laws. Training is a computational-intensive task (typically using Deep Neural Networks) for which GPU processors are particularly well-suited. Once trained, in the example of autonomous driving, NVidia's Xavier platform would be used for *inference*, which is the application of the trained algorithm in real-world cases. In terms of revenue from NVidia's autonomous business, Pegasus sales would ramp first, with the deployment of training infrastructure and Xavier sales would follow, with the number of autonomous vehicles sold.

Autonomous vehicles are not expected to hit the road in volume for a few years, but NVidia is addressing a broad range of AI applications today, ranging from healthcare to eCommerce to smart cities. A major strength of NVidia is the software which runs on its GPUs, called CUDA. Software integration is a key competitive advantage for NVidia, which has helped establish it as the leader in ML/AI semiconductor-applications, and one of the largest semiconductor companies in the world. Annual sales are expected to reach $13 billion in 2020, on the strength of its latest line of GPUs used in gaming and graphic arts, as well as from upgrades at hyperscale cloud companies that are among NVidia's largest customers. In our view, NVidia is one of the best-positioned companies for the adoption of ML and AI across a wide range of industries.

Summary

In the future, our ancestors likely will look back on this time as when some of the most important and far-reaching decisions related to ML and AI were made. Should AI be used to control a moving vehicle? Should AI be used to limit speech? Should AI be used in autonomous weapons? The

technology has come a long way since the late 1960s and any resemblance to HAL 9000 is a reflection of the humans who have developed the technology. Recent breakthroughs in ML/AI will have a major impact on the incorporation of more "ethical" decision-making capabilities. Ultimately, the ability for ML/AI to enhance productivity will one of the most attractive investment themes of our time. It is likely that each company's competitive strength will be evaluated based on how well it can adapt and thrive in an AI-driven world.

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[1] http://www.oecd.org/sti/ieconomy/oecdguidelinesontheprotectionofprivacyandtransborderflowsofpersonaldata.htm

[2] https://ai.google/responsibilities/responsible-ai-practices/?category=general

[3] http://infolab.stanford.edu/~backrub/google.html

[4] https://www.techspot.com/news/81119-photos-becomes-ninth-google-product-pass-one-billion.html

[5] Consensus sell-side analyst estimate for 2020 is 20% revenue growth.

[6] Understanding in the context of scores in the General Language Understanding Evaluation (GLUE) benchmark, https://gluebenchmark.com/

[7] BERT stands for "Bidirectional Encoder Representations from Transformers"

[8] https://investor.fb.com/resources/default.aspx

[9] Facebook financial reports as of 3Q/2019.

[10] 2019 estimates.

[11] https://www.reuters.com/article/us-russia-yandex-governance/yandex-shareholders-approve-governance-changes-to-allay-kremlin-fears-idUSKBN1YO1O9

THOMAS KRYGOWSKI, PhD, CFA
Principal, Portfolio Manager, Strategy Leader

19 Years of Experience

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