

Artificial Intelligence: Industry Report & Investment Case

SOFIA SARAVIA AND EFRAM SLEN, NASDAQ GLOBAL INFORMATION SERVICES

The Rise of Artificial Intelligence

Artificial Intelligence (AI) is the augmentation and imitation of human activity and behavior to increase output or efficiency. Driven in large by technological advancements and an increase in implementation and demand, this burgeoning field has gained a lot of attention in the last few years. However, its underlying sciences have been in development for decades. By the 1950's, a generation of scientists discussed the concept of an artificial brain. In 1956, John McCarthy coined the term AI when he, along with other researchers, claimed in their proposal for the Dartmouth Research Project on AI that **“every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it”**.

This conference marked a catalyst for AI research. Yet, scientists at the time were still limited by insufficient computer speeds and memory, as well as a lack of large, systematized data sets. Recently, explosive growth in Big Data and enhanced computing power allowed AI to flourish. This enabled companies in multifarious industries to adopt AI systems into their product lines. What is most interesting today is that because AI is becoming increasingly entrenched in numerous industries, AI innovation in any one of these fields—including semiconductors, smart robotics, and driverless cars—feeds the others, creating a multiplier effect on the growth of AI.

This is a prime example of the Fourth Industrial Revolution we are in, defined by Klaus Schwab, Founder and Executive Chairman of the World Economic Forum, as a “range of new technologies that are fusing the physical, digital and biological worlds”. The fusion and harmonization of fields allows them to grow more rapidly, and AI is an essential part of this breakthrough. This is one of the reasons why AI is geared for exceptional growth.

The following analysis will define AI and compare it to machine learning, explain the elements that are driving growth in the space, illustrate the industry outlook, and then finally show the reasons as to why the product tied to the Nasdaq CTA Artificial Intelligence Index (NQINTEL), the WisdomTree Artificial Intelligence UCITS ETF (London Stock Exchange: WTAI), is poised to capture the trends in this industry.

At-a-Glance

The Nasdaq CTA Artificial Intelligence Index provides exposure to the three stages of the global AI industry by selecting companies engaged in the Artificial Intelligence segment of the technology, industrial, medical and other economics sectors that are classified as enablers, engagers or enhancers per the Consumer Technology Association (CTA):

- Enablers (40%): Develop building blocks
- Engagers (50%): Design, create or deliver products, software or systems
- Enhancers (10%): Provide their own value-add

The Index ensures investability, sufficient liquidity and size of the underlying companies.

- Minimum market cap of \$250M
- Minimum 3-Month average daily dollar volume of \$3M
- Minimum free float of 20%

Defining Artificial Intelligence

Artificial Intelligence was formally recognized as an academic field in 1956 when John McCarthy, Marvin Minsky, Nathaniel Rochester and Claude Shannon invited researchers from several fields including neural networks, language simulation and complexity theory to the Dartmouth Research Project on Artificial Intelligence. That summer, the researchers attempted to study and define more clearly the hotly debated concept of “thinking machines”. See a snippet of the original proposal for the summer research project by McCarthy et al below¹.

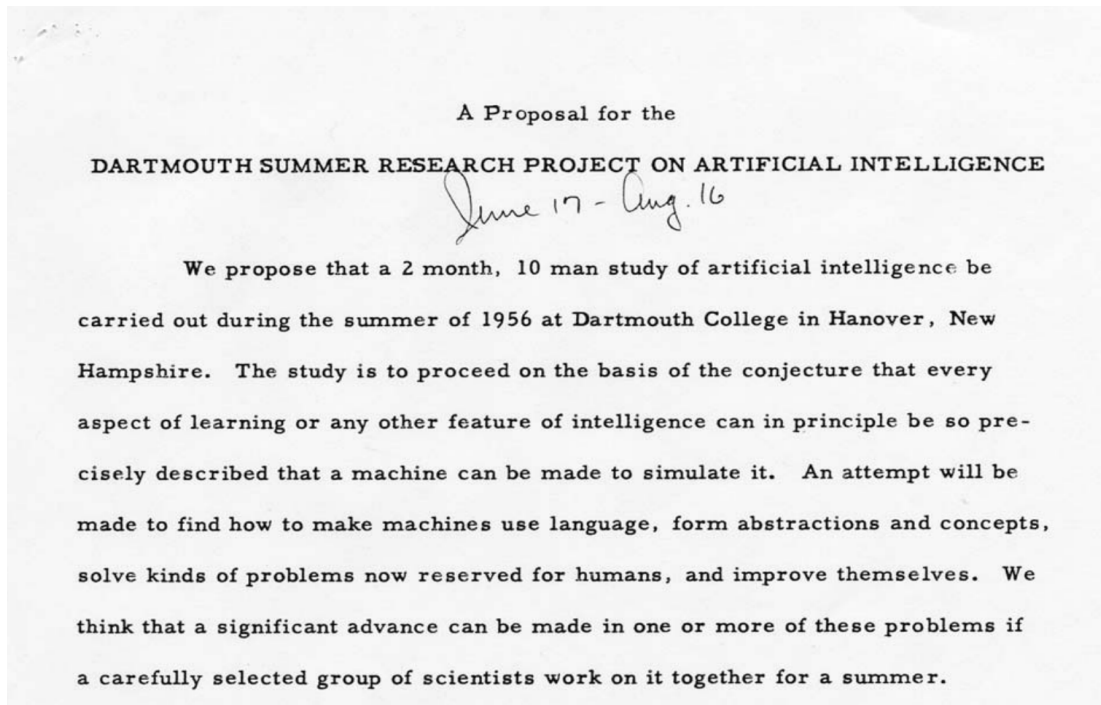


Photo courtesy of Dartmouth College for AI Magazine

Following more than sixty years of progress, artificial intelligence today is the development of computer models to complete tasks that would otherwise require human intelligence. In other words, artificial intelligence algorithms are generally self-trained to carry out tasks with some level of human behavior. The English Oxford Living Dictionary defines AI as “the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.”

AI & Machine Learning

Artificial intelligence and machine learning (ML) are often used interchangeably but they are fundamentally distinct sub-fields within computer science. According to the Consumer Technology Association (CTA), machine learning is the acquisition of knowledge while AI is the application of that knowledge. There can be (and often is) ML without AI, but AI cannot be developed without ML.

Then, how does ML turn into AI? Per CTA, ML goes through the process below to become AI:

Machine Learning

- Data is collected and cleaned
- “Features” are selected from the data
- Tests are run iteratively to tease out features that have predictive power
- Tests produce one or more ML models that can be applied to specific data sets

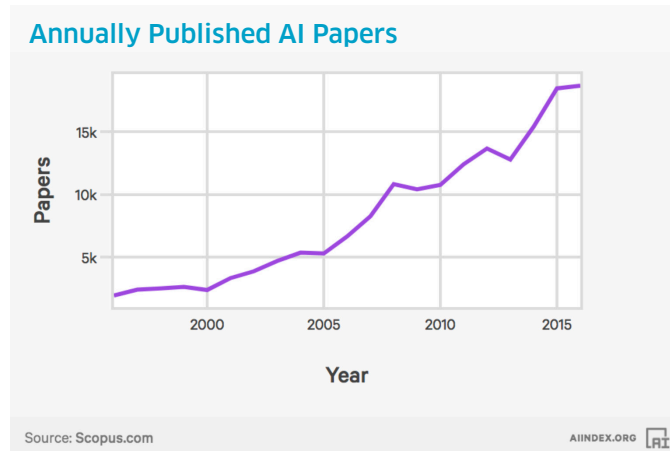
ML can turn into AI when you

- Write code to apply ML models to a decision
- Re-train the models automatically with new data
- Feed new ML models back into the decision system
- Glean and apply new insights without human intervention

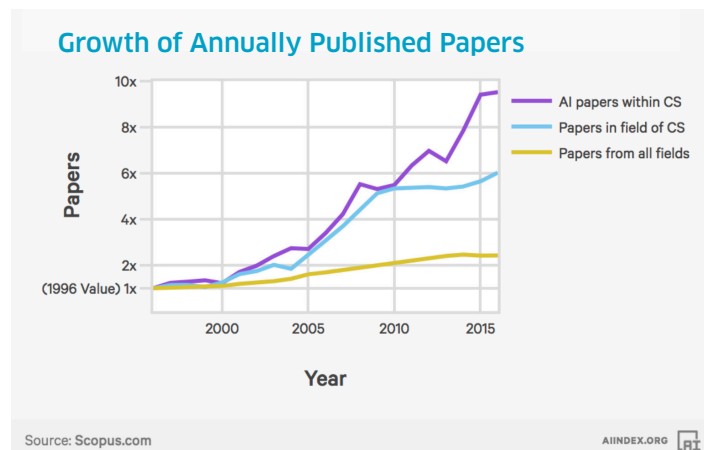
What is Driving the Growth in Artificial Intelligence?

If AI has been in development for the past 60 years, one may wonder why it is until now that the field is growing faster than ever before.

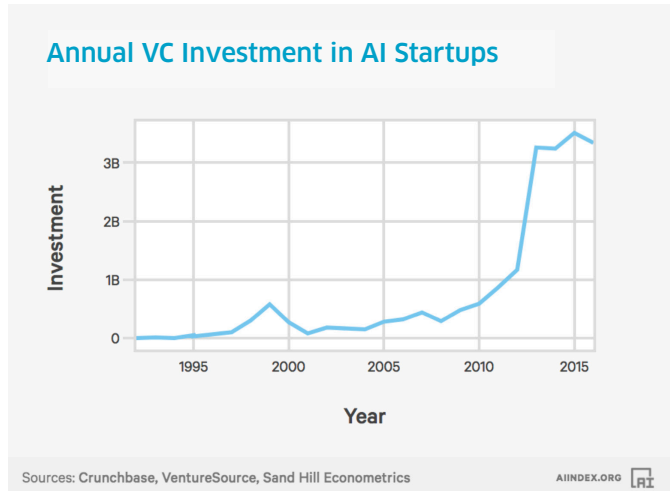
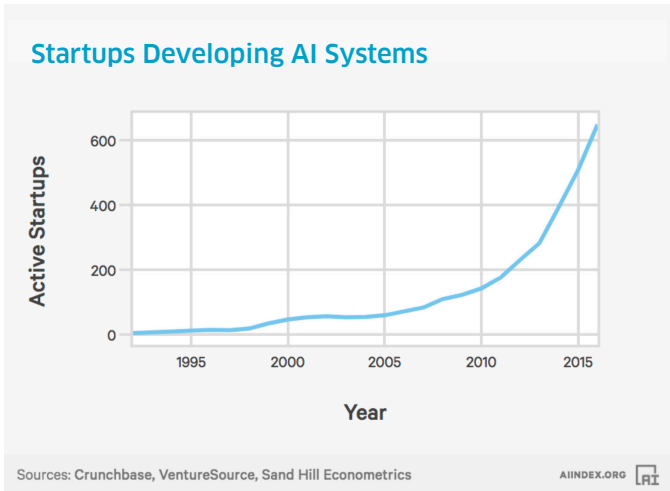
One reason is that AI research has been exploding. Some of these insights are captured by Stanford University's AI Index report², which shows the number of Computer Science research papers that mention "Artificial Intelligence" has grown more than nine times since 1996.



Comparing academic papers from all fields, papers in the field of Computer Science (CS), and AI papers within CS, the Stanford report also found that the annual publishing rate of AI papers within CS has experienced the fastest growth of the three, relative to publishing rates in 1996.

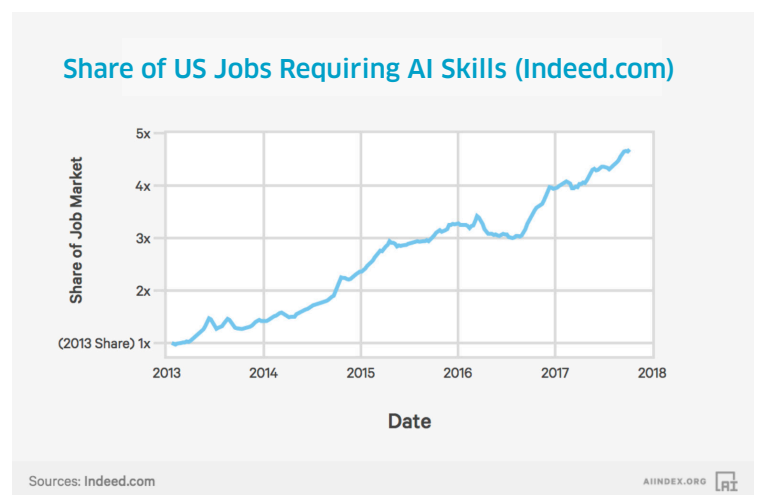
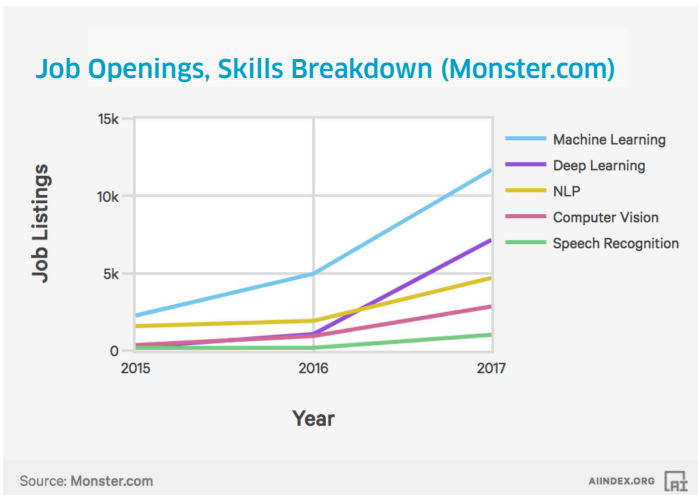


There has also been considerable development and investment in AI, with more startups developing AI systems and more venture capital firms funding them, as shown in the charts below.



In the labor market, the three most in-demand skills are machine learning, natural language processing (NLP) and deep learning—all of which are AI-related skills—according to Monster.com.

While many fear that AI will replace a large amount of the economy’s jobs, AI is also creating many other highly specialized roles. In fact, the share of jobs requiring AI skills has grown 3.5 times since 2013, using data from Indeed.com and published in the same AI Index report.



Some recent technological breakthroughs that are driving growth in the AI field are the following:

- **Unlimited access:** Cloud computing and public data are growing rapidly, enabling a breakthrough in AI computational capability.
- **Big Data:** Artificial intelligence feeds on data to analyze it and make strategic “intelligent” decisions. The International Data Corporation predicts that the amount of data in the world will grow more than ten times by 2025 to 175 zettabytes (ZB) from the 16.1ZB of data generated in 2016³.
- **Knowledge Sharing:** If one AI algorithm learns something, that lesson can be easily distributed to other algorithms. AI and machine learning are therefore more scalable when compared to human learning.

Other factors like adoption, demand and investment are also impacting the field:

- **Demand for Augmented Human Function:** Average productivity changes in the nonfarm business sector fell from 2.6% during the 2000-2007 period to 1.2% from 2007-2017⁴, according to the Bureau of Labor Statistics, and artificial intelligence algorithms, products or services that would help increase productivity measures hold promise.
- **Adoption Among Professional Services:** Robo advisors, a way to invest capital into the financial markets, is a great example.
- **Government R&D:** The UK announced £68 million pounds (about \$94.2 million USD) in funding for AI and robotics research on November 8th 2017⁵; China is building an AI research industrial park for \$2.1 billion USD⁶; and the US is already leading in AI research funding.

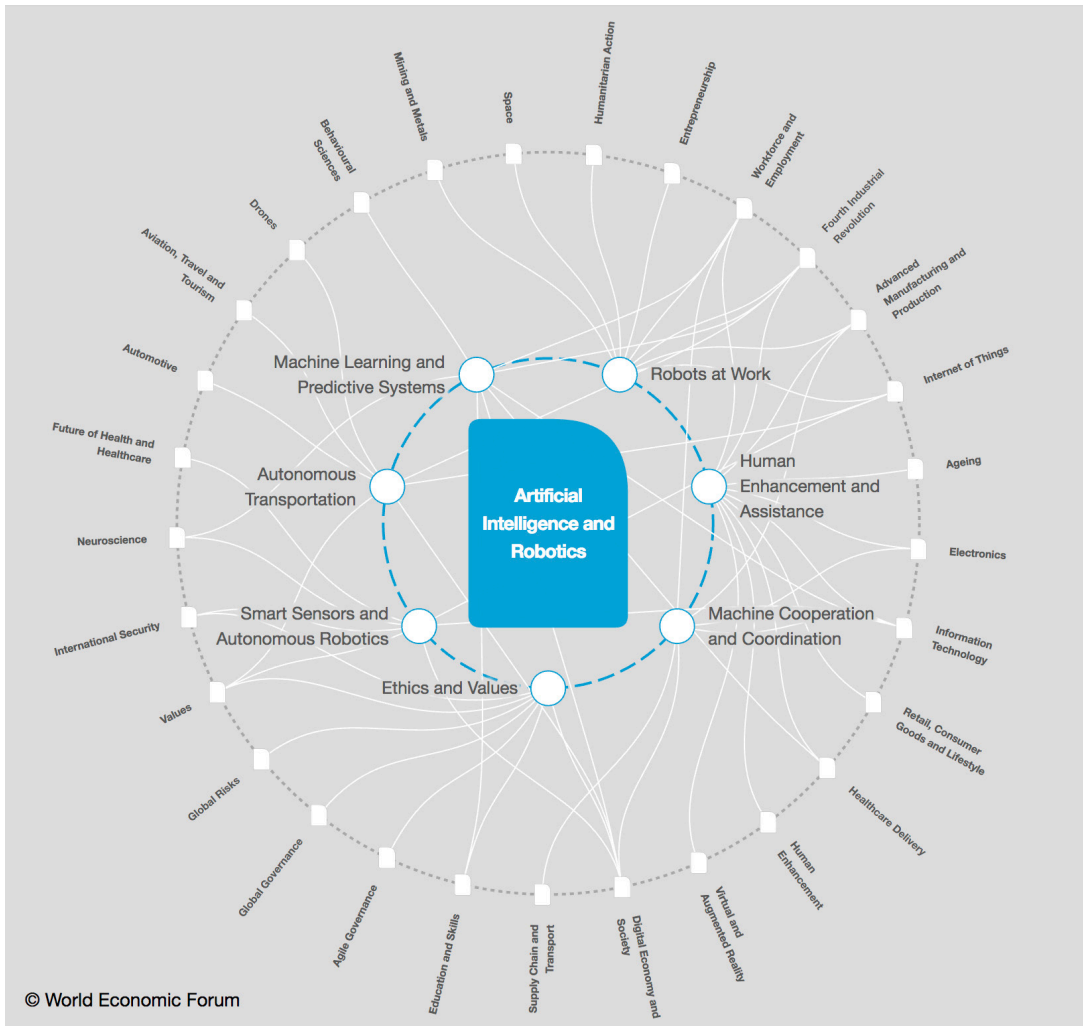
AI in the Fourth Industrial Revolution

AI theory and technology has experienced exceptional growth due to some of the technological and research advancements in recent history mentioned above. But perhaps more importantly, they have been developed to a point that allows these technologies to be used in fusion, cooperation and harmonization. Therefore, AI development in one of the fields of application—including semiconductors, software, automobiles and telecommunications—boosts growth in the others because they are interconnected. This multiplier effect is what is driving exponential growth in the AI field.

From the invention of the steam engine and the birth of the factory during the first industrial revolution to the use of electricity applied to mass production to the digital revolution, the Fourth Industrial Revolution is characterized by a “range of new technologies that are fusing the physical, digital and biological worlds impacting all disciplines, economies and industries, and even challenging ideas about what it means to be human” according to Klaus Schwab, founder of the World Economic Forum (WEF), in his book *The Fourth Industrial Revolution*.

The Fourth Industrial Revolution is different from the three previous ones for three reasons: 1. velocity, 2. scope and 3. systems impact⁷, and Artificial Intelligence is an essential part of this revolution. In fact, Schwab also states that **“robotics, and artificial intelligence generally, are truly at the epicenter of the Fourth Industrial Revolution”**.

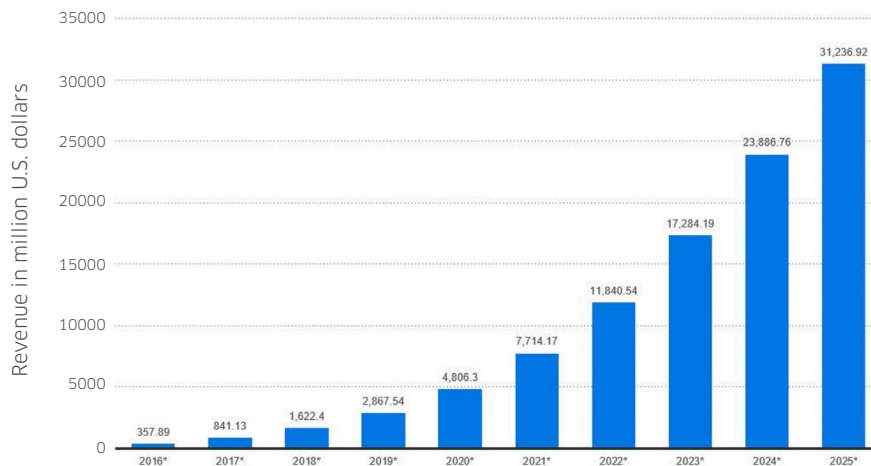
An interconnected map by the WEF shows how the Artificial Intelligence field, along with robotics, stems from the center of the Fourth Industrial Revolution and impacts numerous concepts and industries across many sectors.⁸



What is the Industry Outlook for Artificial Intelligence?

According to Statista, global revenues from AI for enterprise applications is forecasted to grow from \$1.6B in 2018 (projected) to 31.2B in 2025, growing at a CAGR of 52.6% in this seven-year period.⁹

Enterprise artificial intelligence market revenue worldwide 2016-2025
 Revenues from the artificial intelligence for enterprise applications market worldwide, from 2016 to 2025 (in million U.S. dollars)



The competitive landscape in this field is currently dominated by large international companies who are able to design, produce or enhance robots and/or artificial intelligence at a low cost and are able to generate revenue both from direct and indirect sales. Some of the largest leading companies in the space are Amazon, Samsung, Tesla and Alphabet. However, in addition to very well-known technology giants there are smaller companies, like technology company Blue Prism, communication network company Ciena and thermal imaging company Flir Systems, which are breaking into the space by providing highly specialized AI products or services.

Some of the primary markets that AI companies are targeting are:

- Semiconductors
- Software
- Internet & Computer Services
- Industrial Machinery
- Specialized Consumer Services
- Broadline Retailers
- Telecommunications
- Defense
- Automotive

How Can People Invest in the Artificial Intelligence field?

Investors can gain access to the global Artificial Intelligence space through the WisdomTree Artificial Intelligence ETF (London Stock Exchange: WTAI) that tracks the Nasdaq CTA Artificial Intelligence Index (NQINTEL).

The Index is constructed such that the underlying securities represent a robust coverage of the space while ensuring investability, adequate liquidity and size.

Eligibility criteria:

- Minimum market cap of \$250M
- Minimum 3-Month average daily dollar volume of \$3M
- Minimum free float of 20%
- Classified as an Artificial Intelligence company as an enabler, engager or enhancer as determined by Consumer Technology Association (CTA):
 1. Enablers are companies that develop the building block components for artificial intelligence, such as advanced machinery, autonomous systems/self-driving vehicles, semiconductors, databases used for machine learning
 2. Engagers are companies that design, create, integrate, or deliver artificial intelligence in the form of products, software, or systems
 3. Enhancers are companies that provide their own value-added services within the Artificial Intelligence ecosystem, but which are not core to their product or service offering

The top 15 securities (or more inclusive of ties) within each of the three categories—enablers, engagers and enhancers—are selected for a total of 45 (or more inclusive of ties) securities in the Index at the time of the semi-annual evaluations utilizing CTA's AI Intensity Rating. This rating is designed to capture the perceived degree of a company's AI sector involvement within each respective engager, enabler and enhancer category.

The index employs a modified equal weighting methodology where each category receives the following weights:

- Enablers: 40%
- Engagers: 50%
- Enhancers: 10%

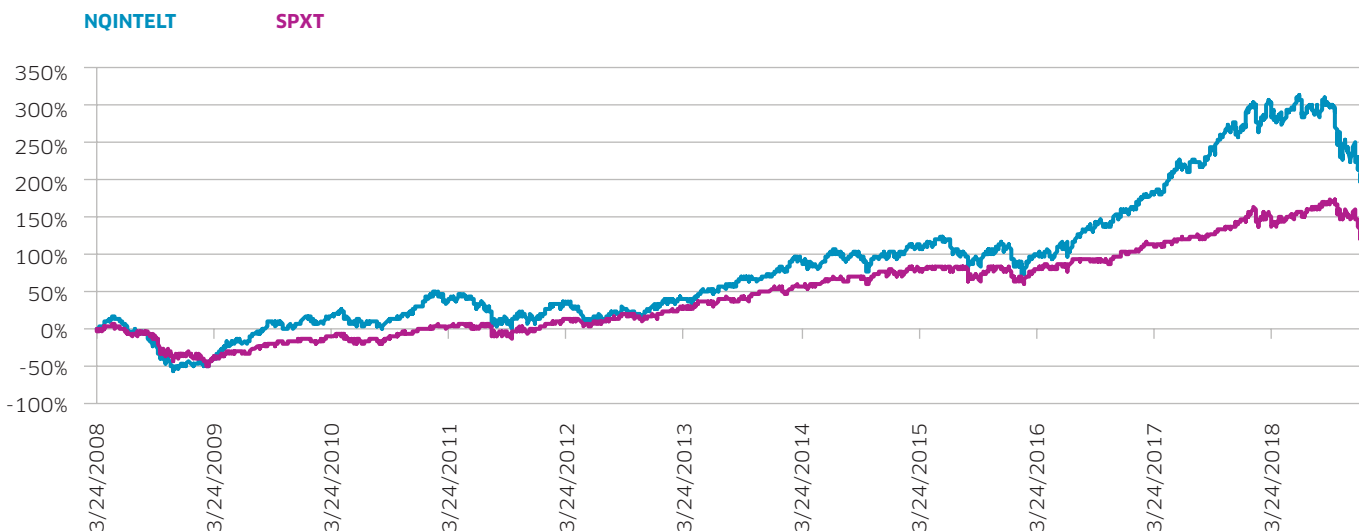
With each category having 15 securities, what that means is that, as of each rebalance, each security classified as an enabler is assigned a weight of $40\%/15 = 2.66\%$, each engager is assigned a weight of 3.33% , and each enhancer is assigned a weight of 0.66% . Then, a liquidity adjustment is applied to reduce the weight of illiquid securities, where necessary. The excess weight is re-distributed across other securities in the respective category or across the whole Index if necessary. Lastly, a 4.5% cap is applied to all securities in the Index.

The reasoning behind why the largest weight is assigned to the engagers category is that AI products developed, integrated or delivered by companies in this category account for a large portion of the company’s revenue. Following a similar logic, companies in the enablers category receive a significant yet more indirect impact in terms of revenue from AI products. Last, it is important to capture companies that overlay their own value-added services to devices in the industry, but since these are not the core revenue generating services of the companies in question, the enhancers category is capped at a lower weight.

The Index is evaluated semi-annually in March and September using data through the end of January and July. The results of the semi-annual evaluations go effective after the close of trading the third Friday in March and September. Note that these weights are assigned as of the end of February and August that go effective after the close of trading the third Friday of March and September.

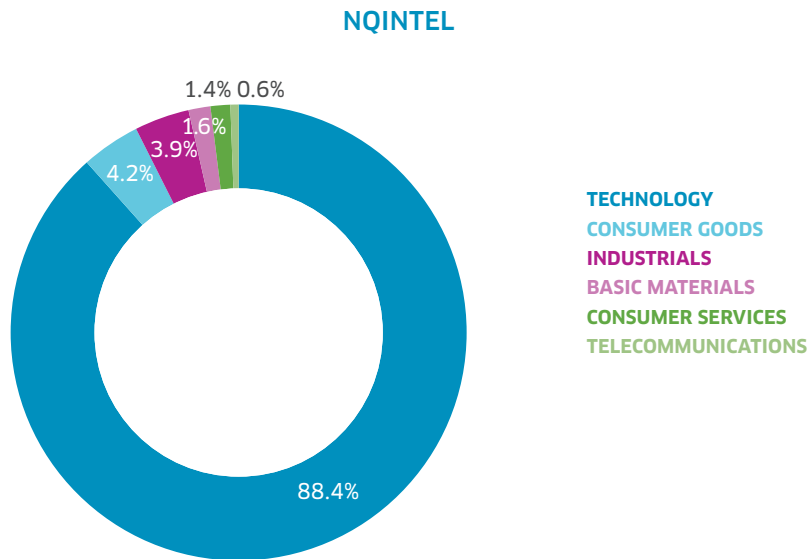
The Nasdaq CTA Artificial Intelligence Index from a total return standpoint (NQINTELT) significantly outperformed the S&P 500 TR Index. Though the live Index officially launched on October 29, 2018, NQINTELT has outperformed the S&P 500 TR Index by 91% since its first day of back-tested history in March 24, 2008 through January 18, 2019.

Total Return Performance



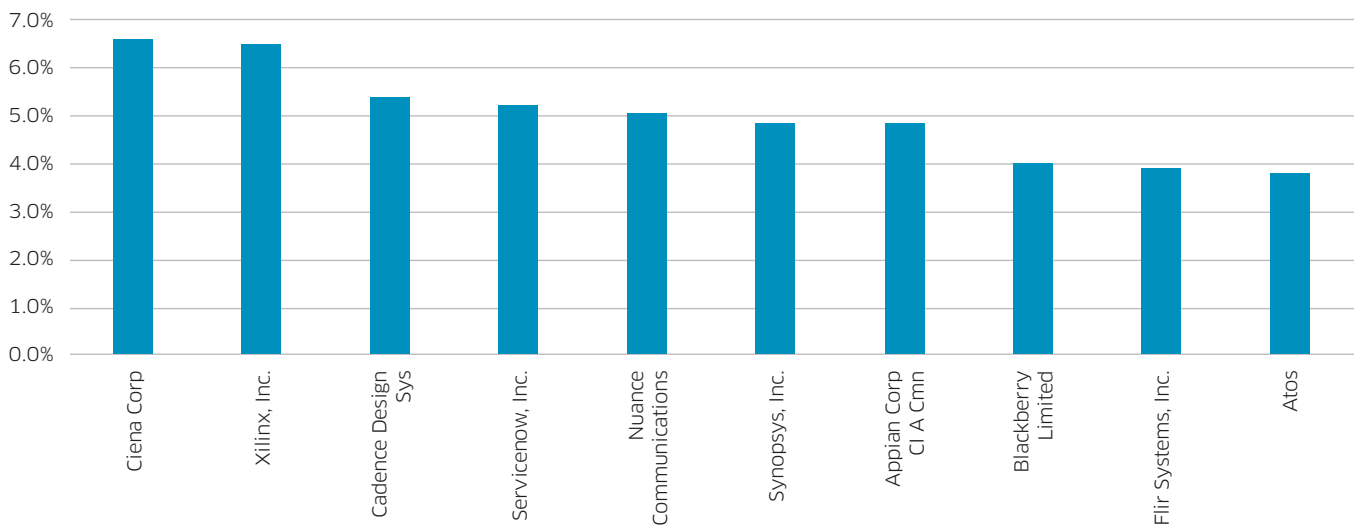
From an ICB Industry perspective, it is not surprising to see that the vast majority of the underlying companies fall in the Technology industry.

While it is helpful to see the way in which securities are classified within a classification framework such as ICB, it is important to note that the diversification element within this Index is truly driven by the different types of AI companies: engagers, enablers, and enhancers. As such, that is why the Index has the cap at 15 securities within each category inclusive of ties.



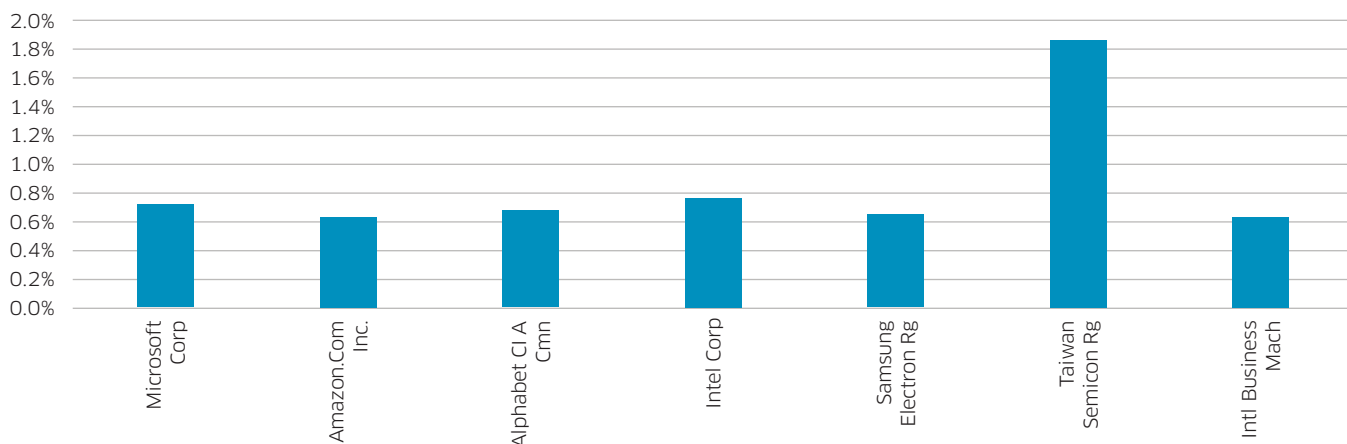
The top ten holdings as of January 18, 2019, are shown here. The average market cap of securities in the top ten was \$11.6B USD.

Top 10 Holdings in NQINTEL (1/18/2019)



Not included in the top ten but in the Index are seven mega cap companies whose market cap was over \$100B as of January 18, 2019. They are shown in the chart with their respective Index weights. Their lower weights indicate that they were not classified as engagers but rather as enhancers or enablers. This shows that, while the mega cap companies are certainly represented in this Index as enhancers and enablers, much larger exposure is given to the types of companies that directly offer products and services related to this space.

Mega Cap Holdings in NQINTEL (1/18/2019)



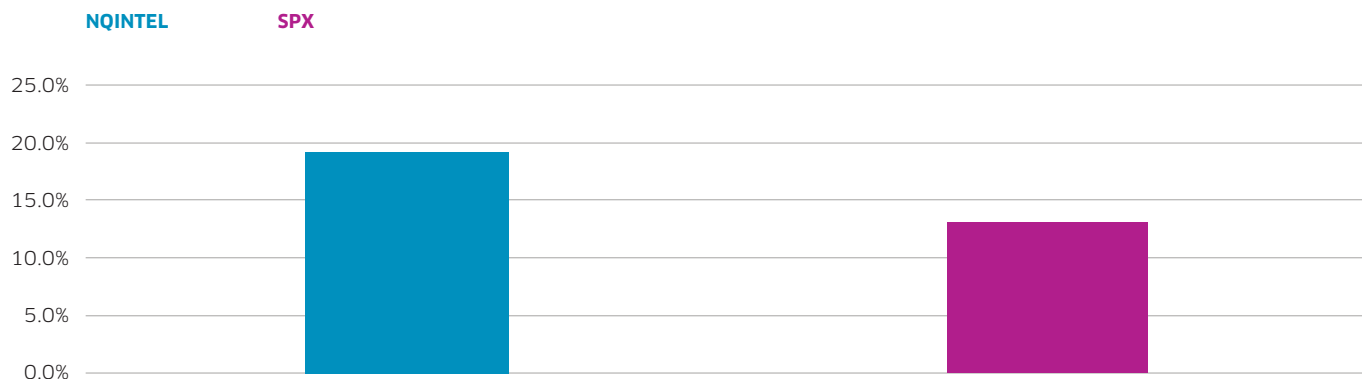
Companies involved in the AI space are typically younger organizations when compared to the rest of the market. In fact, the average IPO date for companies in the Nasdaq CTA AI Index was during 1997, compared to 1982 for companies in the S&P Index 500. Therefore, companies in the S&P 500 Index, on average, have been around for more than 15 years longer.

From a company size perspective, one could assume that most companies involved in AI are typically smaller, start-up-like companies given their younger nature. Yet the opposite is true. Interestingly, as of January 8, 2019, the average market cap of all companies in the Nasdaq CTA Artificial Intelligence Index was more than 50% higher than the S&P 500 at \$80.4B vs \$49.0B. Moreover, from a weighted average market cap perspective (index weight of each security times its respective market cap) the Nasdaq CTA AI Index was more than 80% higher than that of the S&P 500. Companies in the Nasdaq CTA AI Index managed to amass a much higher market cap, on average, than companies in the S&P 500 in much shorter time—this reflects the accelerated growth of companies that are deeply engaged in the field of AI.

	NQINTEL	SPX
Average IPO Date	7/18/1997	2/1/1982
Average Market Cap (\$M)	80,363.7	48,989.0
Weighted Average Market Cap (\$M)	770.3	418.5

Given the nature of the Artificial Intelligence industry, it follows that there is a strong focus on research and development. Taking that in proportion to sales, the Nasdaq CTA Artificial Intelligence Index has a higher figure by almost 50%, on average, than the S&P 500.

R&D as % of Sales



Conclusion

This analysis illustrates how technological advancements, increasing implementation and demand of artificial intelligence products and services, as well as the possibility of merging these fields of application as shown by the Fourth Industrial Revolution, have caused the AI field to grow exponentially. The impact of AI growth spans various industries from semiconductors and software to automobiles and telecommunication. The Nasdaq CTA Artificial Intelligence Index (NQINTEL) offers investors a robust exposure to the global AI market while ensuring investability, sufficient liquidity and size. As a result, NQINTEL's methodology, which includes enablers, engagers and enhancers, captures companies at the three stages of the AI field.

Investors looking for exposure to the Artificial Intelligence industry can invest in the product tied to NQINTEL, the WisdomTree Artificial Intelligence UCITS ETF (London Stock Exchange: WTAI).

Data as of January 18, 2019, unless otherwise stated.

Footnotes:

1. <https://www.aaai.org/ojs/index.php/aimagazine/article/view/1904/1802>
2. <http://cdn.aiindex.org/2017-report.pdf>
3. <https://www.seagate.com/files/www-content/our-story/trends/files/Seagate-WP-DataAge2025-March-2017.pdf>
4. <https://www.bls.gov/lpc/prodybar.htm>
5. <https://www.wired-gov.net/wg/news.nsf/articles/Funding+for+84+million+for+artificial+intelligence+and+robotics+research+and+smart+energy+innovation+announced+09112017081000?open>
6. <https://www.reuters.com/article/us-china-artificial-intelligence/beijing-to-build-2-billion-ai-research-park-xinhua-idUSKBN1ES0B8>
7. <https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/>
8. <https://toplink.weforum.org/knowledge/insight/a1Gb000001RlhBEAW/explore/summary>
9. <https://www.statista.com/statistics/607681/worldwide-artificial-intelligence-for-enterprise-applications-growth/>

Nasdaq® is a registered trademark of Nasdaq, Inc. The information contained above is provided for informational and educational purposes only, and nothing contained herein should be construed as investment advice, either on behalf of a particular security or an overall investment strategy. Neither Nasdaq, Inc. nor any of its affiliates makes any recommendation to buy or sell any security or any representation about the financial condition of any company. Statements regarding Nasdaq-listed companies or Nasdaq proprietary indexes are not guarantees of future performance. Actual results may differ materially from those expressed or implied. Past performance is not indicative of future results. Investors should undertake their own due diligence and carefully evaluate companies before investing. **ADVICE FROM A SECURITIES PROFESSIONAL IS STRONGLY ADVISED.**

© 2019. Nasdaq, Inc. All Rights Reserved. 0192-Q19