WELLS FARGO
Investment Institute

April 2022

Transformative technologies

Investment opportunities in artificial intelligence and genomics

> “The best way to predict the future is to create it.”
>
> — Peter Drucker

What’s inside

Tomorrow's technology today

In 2018, we published a report titled *Tomorrow's Technology*, which highlighted the transition from the information age to the intelligence age. Since then, innovation in and adoption of faster computing power, robotics, decentralized ledgers, and artificial intelligence (AI) only have accelerated. This report reviews and updates the state of change in computer and related technologies and, secondly, in the transformational technology that underlies genome editing. Data and technology seem ready to carry the economy across the Rubicon.

As we look ahead, both branches of innovation embody a new era of digitalization that is poised to spur the next stage of globalization and catalyze advancement, potentially for decades.

Key takeaways on transformative technologies

- AI is revolutionary and disruptive, and we expect it to permeate a broad array of industries from transportation to financial services this decade.
- Areas where AI and machine learning can have material impact over the near term are digital automation and supply chain management, autonomous driving, and health care and biotechnology.
- Clustered regularly interspaced short palindromic repeats (CRISPR) addresses diseases and disorders by replacing damaged DNA with healthy DNA.
- Faster, more efficient, and more precise CRISPR techniques will likely define genomics' next decade.
- We have a neutral to favorable view on several sectors that can benefit from growth in AI and genomics, including Communication Services, Financials, Health Care, Industrials, and Information Technology.
- There is a broad variety of investment options from technology-focused mutual funds and exchange-traded funds (ETFs) to private placements available to qualified investors.

Key questions we consider in this report

Why are advancements in AI and genomics significant breakthroughs?

What applications in AI will soon become widespread?

How will genomics help address the treatment of common diseases?

What opportunities could these technologies provide to investors?

The age of artificial intelligence

Artificial intelligence

The theory and development of computer systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.

Rapid expansion of AI

The increasing use of AI is due, in part, to the following developments:

- Large collections of data
- Faster computers
- Machine learning

Origin of AI goes back decades

In 1997, IBM's Deep Blue supercomputer defeated world chess champion Garry Kasparov, awakening the world to the amazing power of AI. Ten years later, a team of researchers from Carnegie Mellon University and General Motors Corporation won a driverless-car race after successfully navigating the 60-mile course in four hours. In 2011, the Google Brain deep neural network learned to recognize cats by watching YouTube videos, and in 2018, the first self-driving taxi service, Waymo, launched in Phoenix, Arizona.

There have been many notable accomplishments in the 70 years since scientists coined the term "artificial intelligence," but if it feels like AI technology is accelerating before your eyes, it is. Today, researchers are fine-tuning large language models that allow computers to recognize, predict, and write human language — and even poetry — using billions of parameters.[1] This year, the IRS will use AI and facial recognition software to verify the identity of taxpayers online.[2] Like many other innovations ahead of its time, AI had to wait patiently for the world, and technology, to catch up. It has, and now is the time to understand what that means.

Ingredients for the emergence of AI

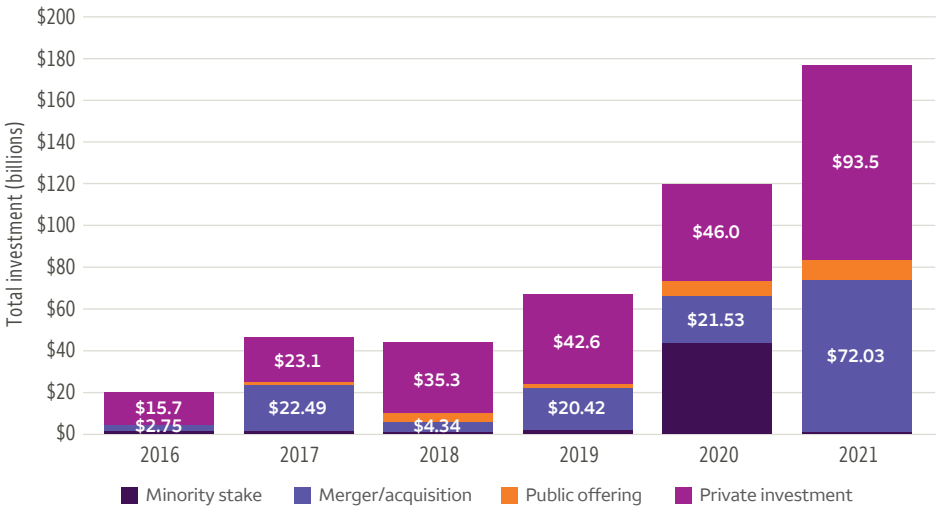
Although AI is not a new concept, only recently have the three key ingredients — big data, faster computers, and machine learning algorithms — converged to propel AI increasingly into new uses. Consider that humans consumed 79 zettabytes of data globally in 2021, which is roughly equivalent to 2.4 *trillion* ultra-high-definition movies. Researchers expect global data consumption to more than double by 2025.[3] Only 65% of the world's population has access to the internet, but that figure rose by 10% in just the first half of 2021.[3]

The proliferation of data is pushing the boundaries of computational power. Some research finds that the computational power used for large AI models has doubled every 3.4 months since 2012, roughly seven times faster than from 1959 to 2012.[4,5] Current supercomputers have over 60,000 parallel processors that are approaching performance levels of one quadrillion (10^{15}) operations per second. In October 2021, Intel announced its Aurora supercomputer would operate 2,000 times faster.[6] Moreover, quantum computers, which may be commercially available within the next 20 years, have the potential to operate millions of times faster than today's most advanced supercomputers.

The simultaneous increase in both data and computational speed has ignited interest among computer scientists in building algorithms to organize and analyze data. In the past six years, AI-related scholarly articles have increased sixfold to nearly 35,000 in 2020.[7] Moreover, as seen in the following chart, global corporations are emphatically embracing AI, increasing investment nearly 48% in 2021 relative to 2020.[7]

Investment in AI is accelerating

Global corporate investment in AI by investment activity, 2016 – 2021



Sources: NetBase Quid, 2020; Daniel Zhang, Nestor Maslej, Erik Brynjolfsson, John Etchemendy, Terah Lyons, James Manyika, Helen Ngo, Juan Carlos Niebles, Michael Sellitto, Ellie Sakhaee, Yoav Shoham, Jack Clark, and Raymond Perrault, "The AI Index 2022 Annual Report," AI Index Steering Committee, Stanford Institute for Human-Centered AI, Stanford University, March 2022

Understanding AI

Alan Turing, the founding father of AI, defines it as "the science and engineering of making intelligent machines, especially intelligent computer programs."[8] The "Turing Test" states that computers need to complete reasoning tests as well as humans to be "intelligent" in an autonomous manner. Simply put, AI combines the fields of computer science, psychology, philosophy, and linguistics in an attempt to make machines do things that require human intelligence.[9] The concept itself dates back to the 1950s, but as the technology has evolved, so too has the definition. The U.S. Department of Defense began paying attention to AI in the 1960s; the Defense Advanced Research Projects Agency (DARPA) completed street mapping projects in the 1970s and designed intelligence assistants in the early 2000s.

Opportunity for growth

65%

Only 65% of the world's population has access to the internet, but that figure rose by 10% in just the first half of 2021.

Sources: Aran Ali, "From Amazon to Zoom: What Happens in an Internet Minute in 2021?", November 2021

Singularity

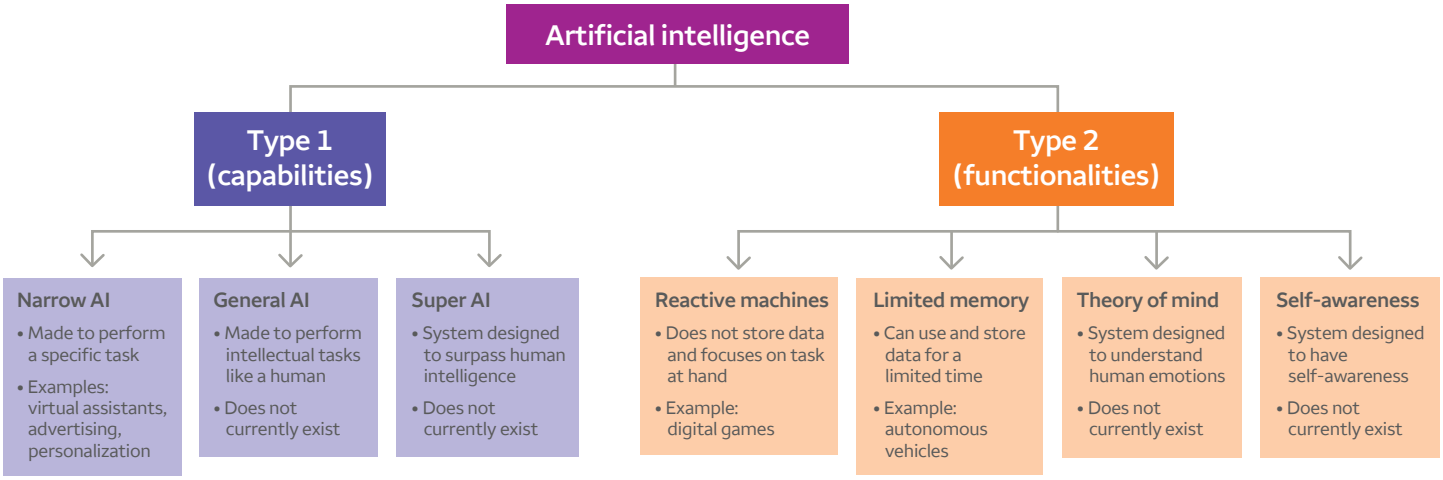
A theoretical point in time when machines are smarter than humans.

Types of AI

Because AI attempts to imitate human intelligence, researchers delineate the technology by its capabilities (Type 1) and its functionalities (Type 2).

Type 1: AI based on capabilities

As seen in the chart below, there are three learning stages of Type 1 AI. The majority of today's AI capabilities are "narrow or weak AI," meaning they increase human intelligence via narrowly defined programmed tasks.[10] Virtual assistants such as Siri, Alexa, and Cortana fall into this category, along with facial recognition software. General AI, also known as strong AI, has fully autonomous and cognitive abilities that will not require human input to function.[11] Super AI goes one step further and offers data processing and memory functions that are superior to humans. Both strong and super AI remain in the theoretical realm for the time being, although some researchers believe we could reach singularity — or the point in time when machines are smarter than humans — in the next 60 years.[12]



Source: Wells Fargo Investment Institute

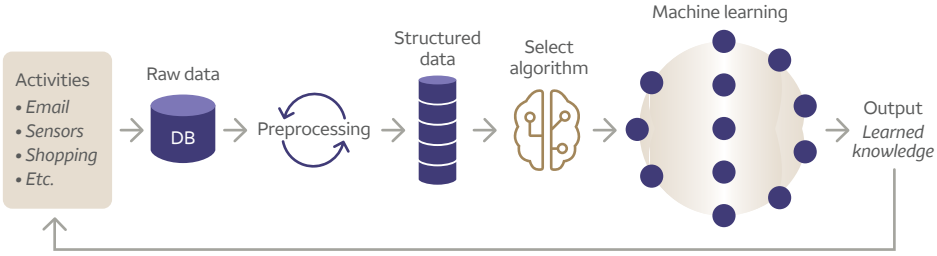
Type 2: AI based on functionalities

Researchers also classify AI into groups based on its functionality. IBM's Watson and Google's AlphaGo are forms of reactive AI that generate predictable output but do not have the ability to learn or conceive of the past and future. Limited memory AI — the classification for autonomous cars — can store data, make predictions, and actually learn from experiences and observation. Theory of mind machines attempt to simulate human intentions and understand motives, while self-aware machines have the same emotions and needs as humans.[13] Just like strong and super AI, theory of mind and self-aware are beyond our current technological capacity.

Machine learning, neural networks, and deep learning

The recent attention and development within the field of AI has focused on machine learning (ML), but the two have important differences. Consider all of these terms like Russian nesting dolls: ML is a subfield of AI, deep learning is a subfield of ML, and neural networks are the foundation of deep learning algorithms.[14] ML is a branch of AI that uses algorithms or models to imitate human learning by looking for underlying trends in large collections of data. The following chart illustrates that ML models first gather a large database (DB), and algorithms analyze the data.[15] An error function iteratively evaluates prediction accuracy and corrects the algorithm, in order to reduce prediction errors.[16]

The process of machine learning

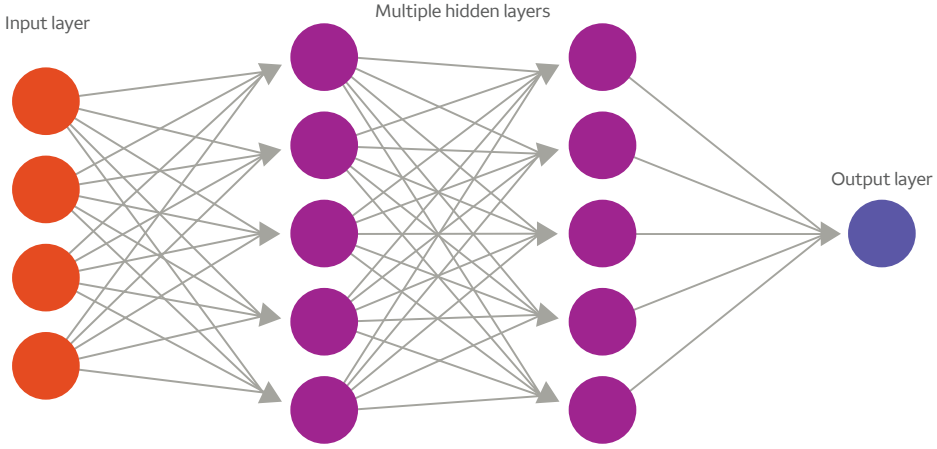


Source: Wells Fargo Investment Institute

Machine learning is a subset of artificial intelligence that uses statistical techniques to give computers the ability to improve performance on specific tasks (or learn).

Neural network and deep learning algorithms are a subset of ML that imitate how brain neurons communicate with each other. A neural network with more than three layers is a deep learning algorithm. Each individual node — or circle — is a model composed of input data, weight, a bias, and an output. Once the input layer is created, weights are assigned based on how important the variable is. The model multiplies the input by its weight, sums it, and determines the output. If the output reaches a certain level, it activates the node and passes data to the next layer in the network and so on.[16]

Deep neutral network



Source: Wells Fargo Investment Institute

A neural network is structured to mimic the organization of neurons in a human brain. Data is analyzed through the input layer, and then again through multiple hidden layers, and finally through an output layer.

AI in everyday life

- Facial recognition on smartphones
- Digital voice assistants
- Personalized online advertising
- Streaming service viewing recommendations
- Mobile check deposits
- Customer service chatbots

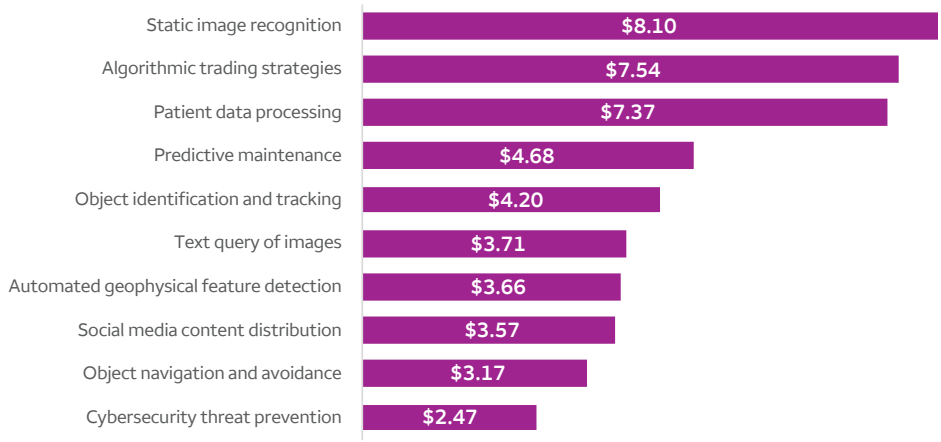
Source: Wells Fargo Investment Institute

Applications of AI today, tomorrow, and in the future

AI is both revolutionary and disruptive, and we expect it to affect nearly every sector and industry within the global economy this decade. The chart below shows revenue forecasts for AI across a wide variety of use cases.

Business growth potential of AI

Forecasted cumulative global AI revenue 2016 – 2025, by use case (in billions)



Source: Statista, January 2022

We see three key areas where AI and ML can have a material impact over the near term, but as the chart on the following page shows, AI adoption is increasing across nearly every industry.

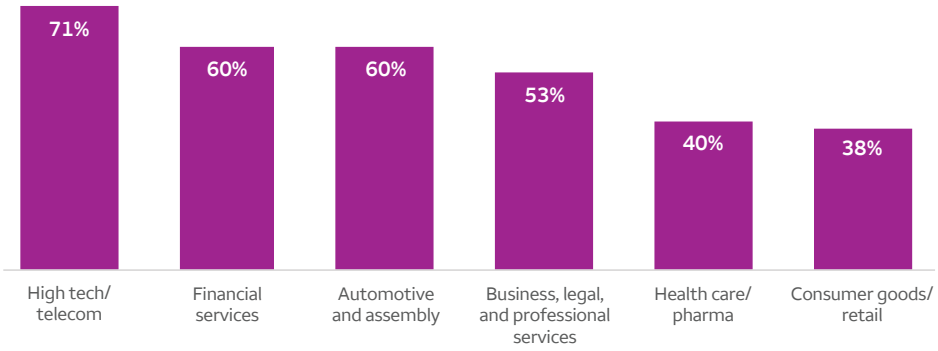
1. **Digital automation and supply chain management:** AI is increasing efficiency in supply chain management, logistics, production, and even facilities management. Robotic process automation (RPA) automates the complex but repetitive tasks that consume finance, human resources, and customer service functions, removing "digital waste" coming from data capture and management, and improving supply chain management. Predictive analytics supported by AI may reduce the error in forecasting demand by 30% to 50%.[17] Performance and order management systems increasingly incorporate AI and ML for automated root-cause analysis, which can identify supply chain risks and reduce delays.

Current forecasts estimate that this year alone, 90% of large and very large organizations will incorporate some version of RPA, up from 55% in 2019.[18] Not only do we expect this trend in AI-facilitated digital supply chain management to accelerate this decade, but a recent survey of process manufacturers suggests that two-thirds expect operations may be autonomously managed by 2030.[19]

2. **Autonomous driving:** With respect to AI innovation, driverless cars and trucks are clearly front and center for companies where logistics are a significant part of costs. AI is critical in the hardware needed for autonomous driving — namely, in the light detection and ranging (LiDAR) radar and cameras for vision, mapping, and computing power. The LiDAR is able to "see" and make instantaneous decisions regarding the distance of objects from the vehicle. Car-to-car communication is also possible through AI, where autonomous vehicles can alert others about upcoming congestion, construction, and accidents.

3. **Health care and biotechnology:** AI tools now exist for identifying a variety of eye and skin disorders, detecting cancers, and supporting measurements needed for clinical diagnosis. Rapidly advancing AI technology allows researchers to build maps of cell genomes and structures that aid in drug discovery. Over the next decade, AI may help scientists build proteins and maps to facilitate gene therapy treatment. Furthermore, some companies can use AI and ML to identify new drug targets based on patient data or identify new use-cases from compounds discarded during the research and development (R&D) process.

AI adoption by industry, 2020



Source: McKinsey & Company, 2020

Levels of driving automation

10-20%

Forecast share of level 4 or 5 autonomous vehicles of all vehicles on the road by 2040.

Source: Littman, 2018

0 No automation
Driver performs all tasks

1 Driver assistance
Driver activates automated system, such as cruise control

2 Partial automation
Driver monitors steering and acceleration

3 Conditional automation
Vehicle performs driving tasks with driver override

4 High automation
Vehicle performs driving tasks within geographic boundaries

5 Full automation
Vehicle performs driving tasks without occupant

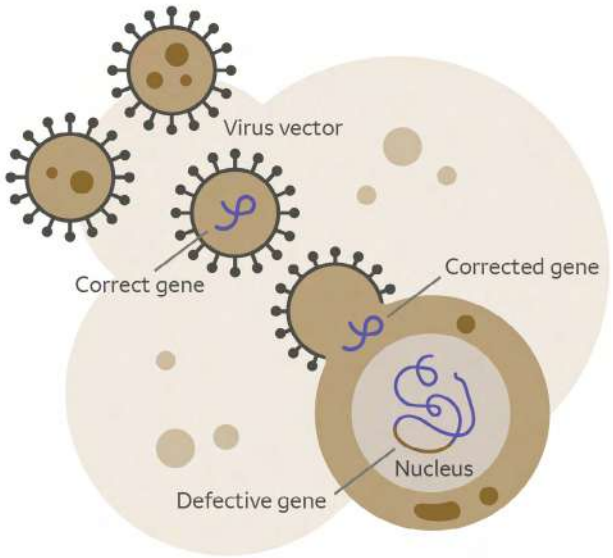
Source: J.D. Power, 2020

CRISPR and the genomics revolution

For 60 years, scientists have been unraveling the mystery of genomics, first by discovering the structure and function of DNA and then researching ways to change that structure to fight disease through gene therapy. As early as the 1980s, doctors recognized that Mother Nature first began modifying genes billions of years ago through viruses, which insert information — either DNA or RNA — into a host cell and provide directions on how to replicate itself.[20,21] Leveraging that process in 1990, doctors used a harmless virus (known as a vector) to insert an enzyme in the cells of a human subject who was suffering from severe combined immunodeficiency.[22] The era of gene therapy was only the beginning of a long road of development.[23]

Gene therapy attempts to treat both inherited diseases as well as acquired disorders by altering a patient's genetic material. Doctors first isolate the defective, disease-causing gene. Then, using a virus (adenovector) that has the ability to enter a cell and deposit genetic material, they replace the defective gene with a corrected gene.

How gene therapy works



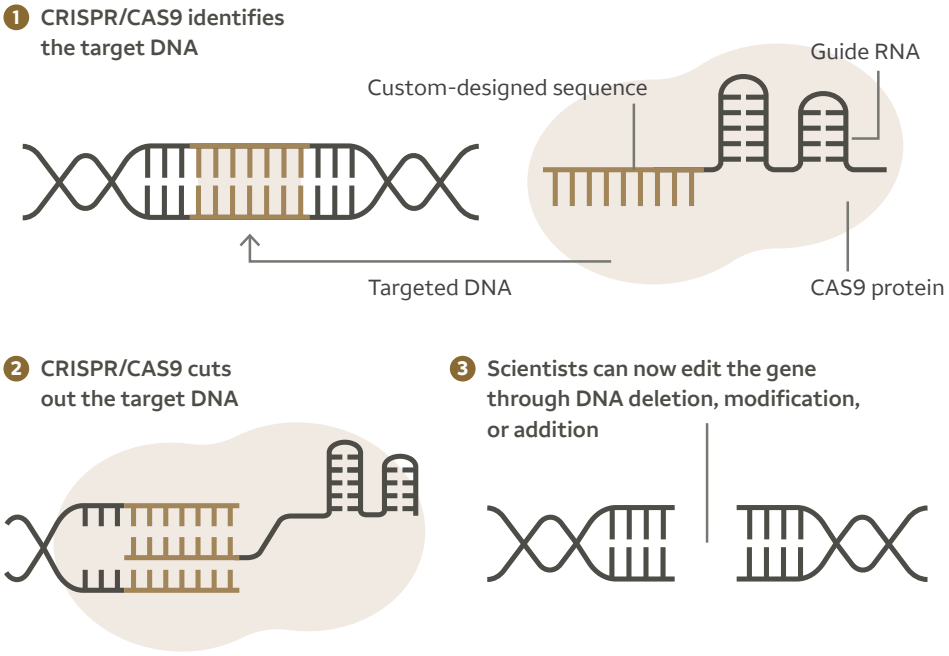
Source: GAO-20-478SP, April 2020

The discovery of clustered regularly interspaced short palindromic repeats, now known simply as CRISPR, ushered in the equivalent of the space race in the 21st century. Nearly 20 years ago, Francisco Mojica and Ruud Jansen hypothesized how CRISPR — which is simply sequences of DNA — formed an adaptive immune system to help bacteria fight off viruses.[24] Researchers observed that bacteria could essentially remember the DNA of invading viruses. If a subsequent viral attack occurs, the CRISPR arrays tell the bacteria to target and destroy the viral DNA.

The pace of scientific discovery accelerated dramatically in the 2000s, with multiple groundbreaking discoveries helping scientists better understand how CRISPR was able to isolate and remove strands of DNA. In 2010, Sylvain Moineau discovered how CRISPR can replace damaged DNA with healthy DNA. This specific discovery sparked one of the greatest scientific races of our

generation, with scientists globally recognizing the potential to engineer a system to locate, remove, and insert DNA into the genome. A new era of life sciences — known as gene editing — had begun. In six months, from June 2012 through January 2013, Jennifer Doudna and Emmanuelle Charpentier raced against labs run by Feng Zhang, Virginijus Siksnys, and George Church to harness the CRISPR/Cas9 system for gene editing.

Gene editing using CRISPR — replacing damaged DNA with healthy DNA



Source: Wells Fargo Investment Institute

Scientists use the CRISPR/Cas9 system to cut a specific DNA sequence. In step 1, scientists first create the guide RNA that matches the piece of mutated DNA they want to modify. Then they combine the guide RNA with the Cas9 protein. In step 2, scientists inject the guide RNA and Cas9 protein into the patient. With the help of the protospacer adjacent motif, the guide RNA locates the mutated DNA and the Cas9 protein cuts out the unhealthy DNA sequence. In step 3, scientists can then insert healthy DNA in place of the removed sequence.

Gene editing technology in the next decade

Faster, more efficient, and more precise techniques for locating, breaking, and repairing DNA likely will define the next decade of genomics. Addressing the risks associated with gene editing is equally important. Consider this the collateral damage up or downstream from the location of the DNA break, with such adverse reactions leading to genetic mutation and even disease. For instance, researchers are focusing on site-specific recombinases, or SSRs, which edit DNA without relying on a viral vector to introduce new DNA at the break. With SSRs, locating and simply switching the orientation of a DNA segment — much like a railroad switch — has applications within synthetic biology in the use of biocomputers.[25] Other areas of focus include simple base pair editing, which can help scientists avoid unintended mutations.[26] Lastly, rather than relying on genes to edit DNA, researchers are exploring simply using enzymes as proteins, which self-destroy rather than being continually "expressed" as a gene would. This may greatly limit the off-target effects.

Economic impact

Research studies show that genomics creates $1.45 in the U.S. economy for every $1.00 spent, with the industry supporting an estimated 850,000 jobs, including 152,000 jobs in core occupations.

Source: Congressional Research Service, Advanced Gene Editing: CRISPR/Cas9, December 2018

Taking on the big six with genomics

It is a daunting task to keep track of the potential implications of gene editing technology. According to the Scopus database of peer-reviewed research, scientists published nearly 13,000 papers related to CRISPR from 2011 through 2018.[27] Perhaps the most encouraging and exciting aspect of genomics is the broad spectrum of diseases and conditions that are potentially treatable or preventable. The table below shows a glimpse into the research being done across the six major classifications of disease afflicting society today.[28]

Research implications are far-reaching

Research classification	Current and future areas of focus	Role of CRISPR/Cas9
Cancer	Chronic myeloid leukemia (CML), Ewing sarcoma, anaplastic large cell lymphoma (ALCL), prostate and breast cancers	Prevention and treatment of various cancers by isolating and removing DNA mutations and replacing those sequences with normal, healthy DNA
Cardiovascular disease	Childhood onset cardiomyopathy, Marfan syndrome, congenital heart disease, long QT syndrome, and other hereditary heart conditions	Repair mistakes in cardiac muscle tissue
Metabolic disease	Obesity, diabetes, and hyperlipidemia	Researchers are applying CRISPR/Cas9 technology to stem cells to understand better the molecular mechanisms of diabetes
Neurodegenerative disease	Huntington's, Alzheimer's, and Parkinson's diseases	Gene editing platforms are offering researchers a better method of studying gene functions and their impact on neurodegenerative diseases
Viral diseases	COVID-19, HIV, human papillomavirus, hepatitis B	Aside from CRISPR/Cas9 being an invaluable tool in constructing the COVID-19 vaccine, scientists have used gene editing to produce HIV-resistant T cells
Hematological diseases	Hemophilia and sickle cell anemia	Chromosome inversions, which can be corrected using CRISPR/Cas9, can affect how genes direct blood clotting

Source: Hongyi Li et al, "Applications of Genome Editing Technology in the Targeted Therapy of Human Diseases: Mechanisms, Advances and Prospects," January 2020

Investing in AI and genomics

Guidance from the Global Investment Strategy team

We believe that disruptive technology such as AI and CRISPR will touch multiple sectors and industries over the next decade. Therefore, investors should determine not only which companies are driving the innovation but also which areas of the global economy may benefit the most.

The Information Technology sector remains at the forefront in adopting these technological advances, but we are seeing AI permeate a broad array of industries from transportation to financial services. The table below shows what we believe to be some of the most promising sectors and includes our current guidance.

The Information Technology sector remains at the forefront in adopting these innovations.

Many of the well-known genomic companies have tended to have smaller market capitalization and reside in the Health Care sector of the Russell 2000 Index of small-capitalization companies. These biotech firms are generally low quality and typically struggle mid-to-late cycle as liquidity begins to evaporate. We are currently unfavorable small-cap equities, but these smaller-cap firms may present an attractive acquisition opportunity for some of the larger players in the S&P 500 Index in the future.

Areas that could benefit from growth in AI and genomics

Wells Fargo Investment Institute sector guidance (as of April 2022)	
Favorable	**Neutral**
Health Care	Communication Services
Information Technology	Consumer Discretionary
	Financials
	Industrials

Source: Wells Fargo Investment Institute

Overall sector valuations within the Information Technology sector may exceed historical averages, and other risks to watch include regulatory (antitrust) and tax risk as well as supply chain constraints. However, we believe that earnings growth will normalize valuations. Moreover, many of the companies at the forefront of AI and ML innovation have strong financial fundamentals — particularly, low debt and high cash flows — and we believe capital spending and merger/acquisition activity is likely to accelerate over the coming years.

Many of the companies leading AI and ML innovation have strong financial fundamentals — particularly, low debt and high cash flows.

Guidance from Global Securities Research

A number of longer-term trends are converging, including the dramatic increase of connected devices, the fifth generation wireless network (5G), AI, and augmented/virtual realities. In our view, these technologies connect on a number of levels. Many companies involved in the development of the technologies supporting these trends and themes focus on multiple product lines. In our view, the same companies that helped build out the internet will most likely be the ones helping create the backbone and infrastructure necessary to support these technologies.

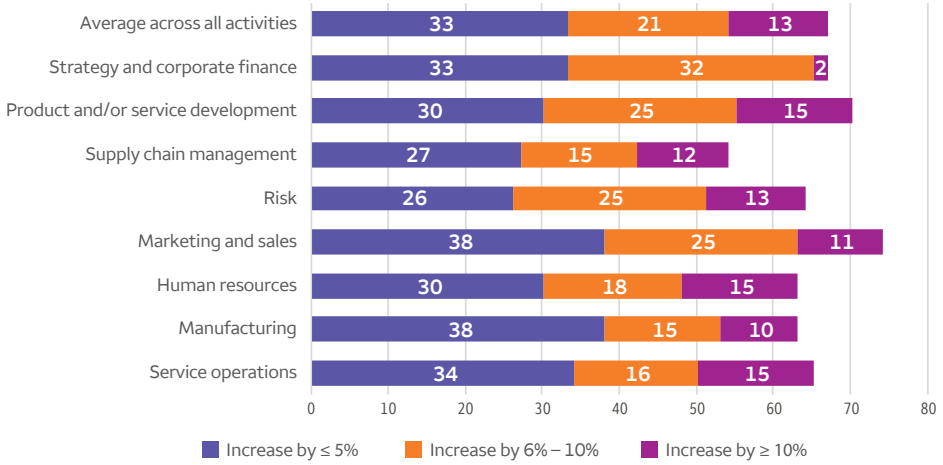
The same companies that helped build out the internet will most likely be the ones helping create the backbone and infrastructure to support these technologies.

Marc Andreessen, a prominent technology entrepreneur and Silicon Valley venture capitalist, famously wrote a Wall Street Journal article in 2011 laying out his thesis that software would "eat the world," which largely came true, as software has disrupted multiple industries. Today, it is widely believed AI is eating the world. Over the past two decades, Big Data supported by rapid adoption of smartphones and mobile apps, advances in high performance computing power supported by the adoption of cloud computing, and advances in machine learning algorithms were instrumental in driving broader advancements in AI.

From a high level, we expect the Information Technology and Communication Services sectors to benefit from the modern evolution of AI. We characterize the current landscape as one of "deep pockets," where the companies with the largest pools of capital and data should ultimately prevail among the multiple long-term technology trends. Simply put, these companies possess the largest amounts of data already gathered through their R&D efforts, and they often boast the largest piles of cash on their balance sheets. Subindustries we believe will benefit from the secular AI theme include software, hardware, semiconductors and semiconductor capital equipment, communications equipment, fintech, internet and media services, and entertainment. As seen in the chart below, respondents in a recent McKinsey & Co. survey are already recognizing an increase in revenue across a variety of functions due to AI adoption.

From a high level, we expect the Information Technology and Communication Services sectors to benefit from the modern evolution of AI.

Revenue increase from AI adoption by function



Source: McKinsey & Co., 2020

The future of the biotechnology sector has become increasingly intertwined and reliant on developments within genomics and gene therapy, and we expect that trend to continue going forward. The biotech sector has witnessed a significant increase in the number of gene therapy and genomics-related companies in existence in recent years, with a substantial increase in private equity funding for these companies. According to the Alliance for Regenerative Medicine, there were approximately 1,200 companies involved in cell-therapy, gene-therapy, or tissue-based treatments in 2021, an increase of approximately 200 more than at the same point the year before. Those companies were involved in over 1,300 ongoing clinical trials, with over 100 products having advanced into Phase 3. As the technology of genomics has progressed, the biotech sector has become increasingly divided into a growing number of genomics-related specialties, including gene therapy, gene editing, gene silencing, and cell therapy.

There were approximately 1,200 companies involved in cell-therapy, gene-therapy, or tissue based treatments in 2021.

Source: Alliance for Regenerative Medicine

Sectors and industries that may benefit

Disruptive technology	Sectors that may benefit	Industries that may benefit	Near-term expectations	Areas to watch
Artificial intelligence	Information Technology Communication Services	Software, hardware, semiconductors, semiconductor capital equipment, communications equipment Interactive media services, telecom infrastructure	Companies with "deep pockets" of capital and data should prevail; existing R&D efforts give them a first-mover advantage in data, alongside elevated levels of cash on balance sheets	Impact of AI on cybersecurity, autonomous driving, and the metaverse
CRISPR/ genomics	Biotechnology Pharmaceuticals	Gene therapy, gene editing, gene silencing, cell therapy	Growth of gene therapy and genomics-related companies expected to continue, aided by private equity funding; significant R&D efforts alongside strategic investments	Heightened M&A as large pharmaceutical companies collaborate or acquire smaller players and clinical data de-risks products under development

Source: Wells Fargo Advisors Global Securities Research

Guidance from Global Manager Research

One of the most straightforward ways investors can get exposure to these innovations is through technology-focused mutual funds (MFs) and exchange-traded funds (ETFs). These vehicles offer investors fast access and liquidity because their portfolios invest in exchange-listed securities of technology-related companies — that is, the publicly traded portion of these companies' debt and equity. Investors have a wide range of choices from global, highly diversified funds to those that focus on specific regions or a particular technology segment. Some funds take a passive investing approach, while others actively manage their portfolios.

Most technology ETFs passively replicate a particular technology index. This could be a broad global index or indexes focused on specific technology sectors or geographic regions. Some products, such as those focused on Communication Services or Health Care, may overlap with other sectors. One advantage of technology ETFs relative to other vehicles is that they provide investors with instantaneous access and near instantaneous liquidity. ETFs also tend to charge low fees and have full, daily portfolio transparency.

The majority of technology MFs, on the other hand, are actively managed. The relative opacity of MFs' holdings (compared with ETFs' holdings) shields some proprietary strategy features, allowing them to implement an effective, active investment approach. Their variety of investment strategies seek to outperform the broader technology market or a targeted technology segment. Some funds have a rules-based approach that parses the listed technology universe and constructs diversified portfolios that meet certain quantitative criteria. Others use deep fundamental analysis to construct concentrated portfolios of securities that the investment teams believe have the highest risk/return potential. As with ETFs, these investments may sometimes have exposure to other sectors that are tangential to technology.

For qualified investors, private technology investments can complement a traditional MF or ETF strategy. In comparison with traditional investments, private technology investments may take on more systematic or unique risks, with the goal of creating value by going up the risk/return curve and potentially generating returns that are more attractive. Investment opportunities in private investments may also specialize — for example, on health care in a particular region. Private investments have a notably higher degree of illiquidity in comparison with more traditional investments. With a longer investment term, the private funds can deploy capital in investments with longer runways to growth. Private technology funds have the flexibility to invest in large and small opportunities around the globe. This may be advantageous for investments in countries with smaller technology markets or in technology companies that are still in their developmental stages.

The next decade of technology begins now

Both AI and genomics build upon innovation and ideas that are decades in the making. Yet, only recently have the technology and data reached a point where theory is becoming reality. AI and ML are increasingly common in the economy, and we believe they will drive growth and discovery for decades to come. And scientists are now at a point where researchers can pinpoint what causes certain diseases and may be able to repair and replace genes that treat serious health conditions. Understanding these technologies, how they work, why they are important, and which industries stand to benefit the most are critical steps in identifying potential investment opportunities into the next decade of technology.

Authors

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Mr. Lenarcic researches alternative strategies, including developing strategy convictions, sourcing, constructing recommended portfolios, and publishing alternative investment commentary. Prior to joining Wells Fargo in 2007, Mr. Lenarcic worked as a quantitative equity analyst. He has more than 17 years of experience in financial services.

Chris Haverland, CFA
Global Equity Strategist

Mr. Haverland is responsible for thought leadership on the economy, financial markets, investment strategy, and asset allocation. He develops equity strategy, researches timely investment topics, and produces market updates that deliver advice to help investors meet their long-term financial goals. Prior to joining Wells Fargo, Mr. Haverland was a portfolio manager, corporate bond analyst, and trader at Jefferson Pilot Financial (now part of Lincoln Financial), where he managed $2.6 billion in fixed-income assets.

Tony Miano
Senior Retail Investment Research Analyst

In his role, Mr. Miano focuses primarily on the analysis of international and global equity strategies. Prior to his current role, Mr. Miano worked as a financial advisor with Wells Fargo Advisors (WFA) Digital and Automated Investing, where he advised clients on WFA's phone- and online-based platforms. He has been with Wells Fargo since 2018.

Peter Winkler III
Senior Lead Retail Investment Research Analyst

In his role, Mr. Winkler focuses on equity strategies, specifically large- and all-cap core asset classes as well as selective option-based strategies. Prior to joining Wells Fargo in October 2016, Mr. Winkler worked at Credit Suisse and focused on investment manager research. He has 10 years of experience in financial services.

Wells Fargo Advisors Global Securities Research

Amit Chanda
Equity Sector Analyst

Mr. Chanda is an equity sector analyst responsible for covering the Information Technology sector. Amit has 23 years of experience in equity research, including 15 years following semiconductor equities. Prior to joining Wells Fargo Advisors in 2019, he was a senior associate analyst at Wells Fargo Securities, Wachovia Securities, and A.G. Edwards following the Information Technology sector.

Thomas Christopher
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Mr. Christopher is an equity sector analyst responsible for coverage of the Communication Services sector with additional extensive experience covering the Information Technology sector. With more than 24 years of experience within the financial services industry, Mr. Christopher is also manager of the High Yield Equity Income List. Before joining Wells Fargo Advisors in 2014, he worked as a financial advisor and research analyst, most recently as an investment analyst with Morgan Keegan and McDonald Financial Group.

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Equity Sector Analyst

Mr. Simpson is an equity sector analyst responsible for covering the Health Care sector. He has over 30 years of experience in the securities industry as an analyst covering the medical device industry and more recently as an investment banker. He joined Wells Fargo Advisors from Benjamin F. Edwards & Co., where he was a managing director in investment banking. Prior to his tenure at Benjamin Edwards, he served as an analyst at Wunderlich Securities, Stifel Financial, and A.G. Edwards.

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Alternative investments, such as private equity funds are not appropriate for all investors and are only open to "accredited" or "qualified" investors within the meaning of U.S. securities laws.

Alternative investments, such as private equity funds, are speculative and involve a high degree of risk that is appropriate only for those investors who have the financial sophistication and expertise to evaluate the merits and risks of an investment in a fund and for which the fund does not represent a complete investment program. They entail significant risks that can include losses due to leveraging or other speculative investment practices, lack of liquidity, volatility of returns, restrictions on transferring interests in a fund, potential lack of diversification, absence and/or delay of information regarding valuations and pricing, complex tax structures and delays in tax reporting, less regulation and higher fees than mutual funds. Private equity fund investing involves other material risks including capital loss and the loss of the entire amount invested. A fund's offering documents should be carefully reviewed prior to investing.

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Sector investing can be more volatile than investments that are broadly diversified over numerous sectors of the economy and will increase a portfolio's vulnerability to any single economic, political, or regulatory development affecting the sector. This can result in greater price volatility.

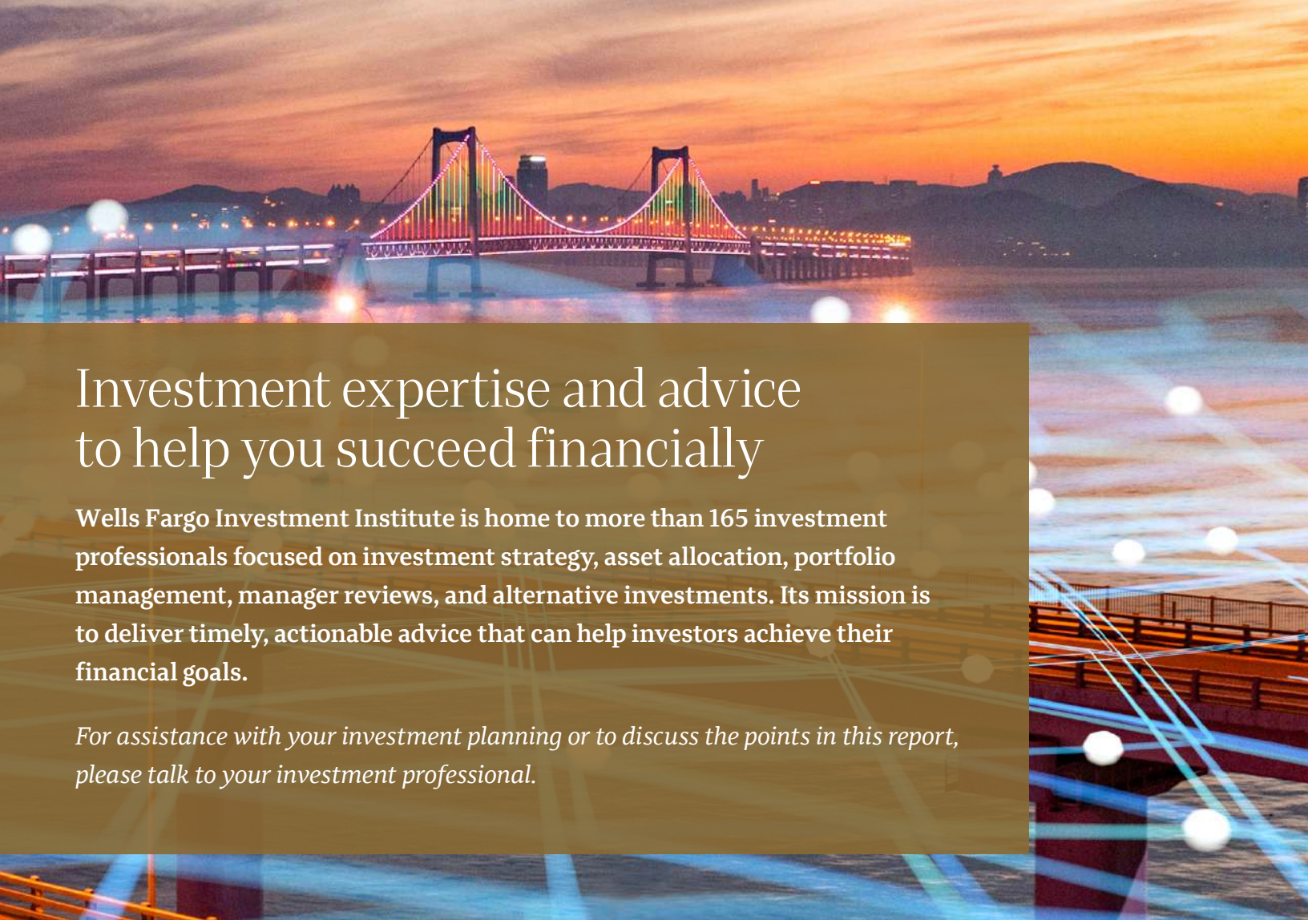
Exchange-traded funds (ETFs) seek investment results that, before expenses, generally correspond to the price and yield of a particular index. There is no assurance that the price and yield performance of the index can be fully matched. ETFs are subject to substantially the same risks as individual ownership of the securities would entail. Investment returns may fluctuate and are subject to market volatility, so that an investor's shares, when redeemed or sold, may be worth more or less than their original cost.

Definitions

Russell 2000 Index measures the performance of the 2,000 smallest companies in the Russell 3000 Index, which represents approximately 8% of the total market capitalization of the Russell 3000 Index. The Russell 3000 Index measures the performance of the 3,000 largest U.S. companies based on total market capitalization, which represents approximately 98% of the investable U.S. equity market.

S&P 500 Index is a market capitalization-weighted index composed of 500 widely held common stocks that is generally considered representative of the U.S. stock market.

An index is unmanaged and not available for direct investment.



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