

How Big Data & Artificial Intelligence Changes the World

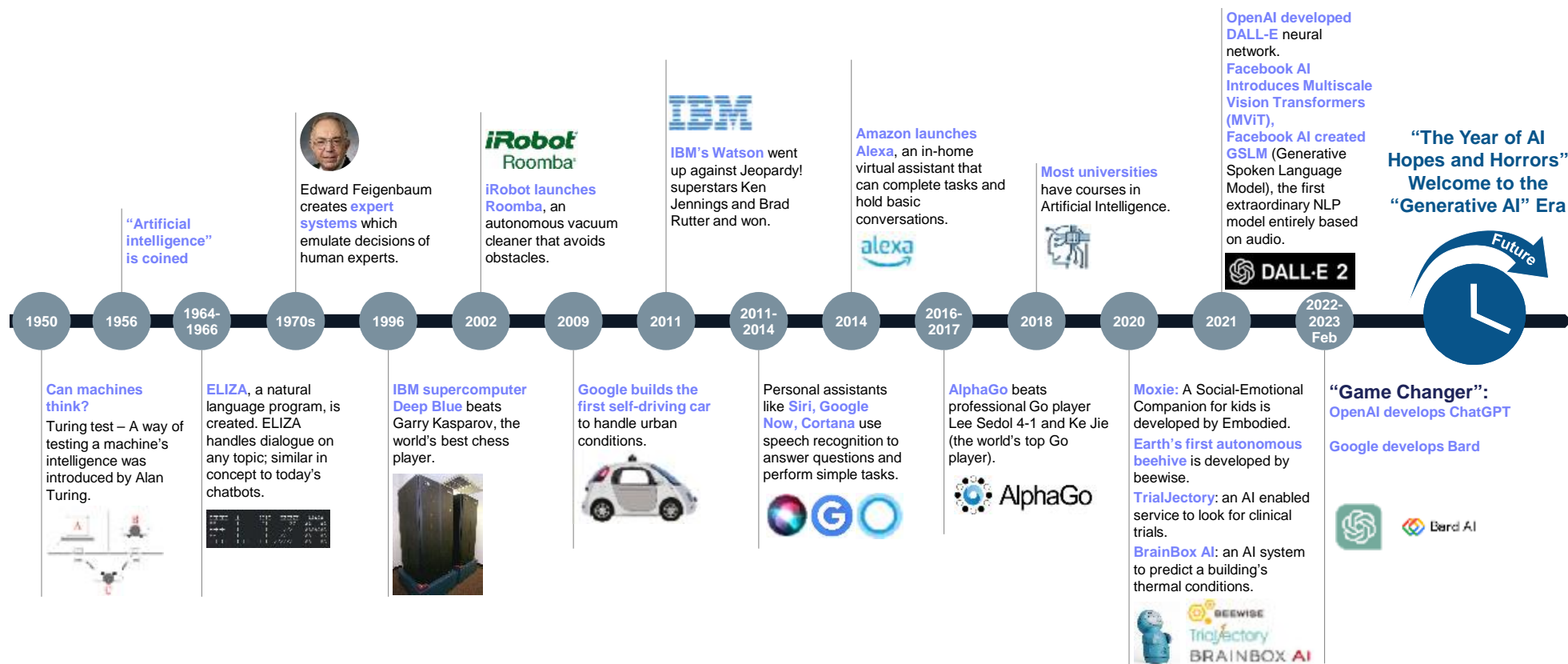
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Quantitative Investment Strategies

September 2023

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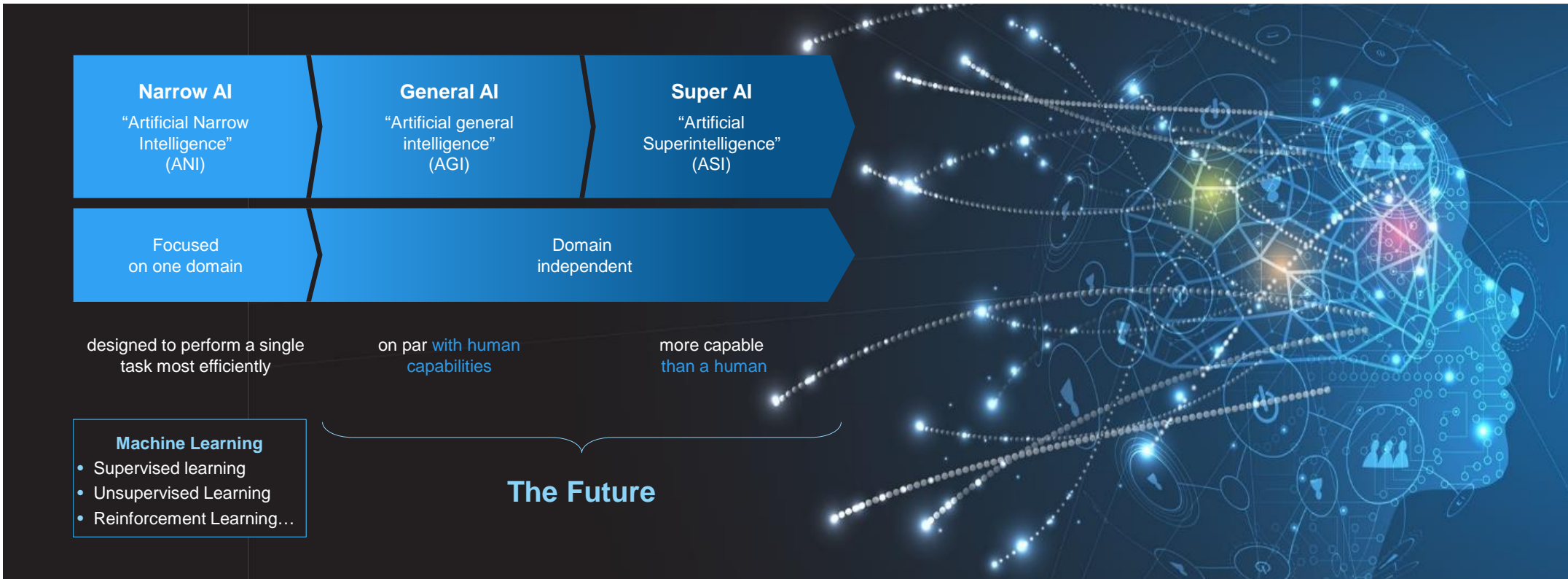
AI is Likely to Be Omnipresent Across Industries



Source: Goldman Sachs Asset Management, Queensland Brain Institute, Thinkml, Forbes, CNN. For illustrative purposes only. Any reference to a specific company or security does not constitute a recommendation to buy, sell, hold or directly invest in the company or its securities.

An Evolution of Artificial Intelligence (AI)

Three Types / Stages of Artificial Intelligence



Source: Goldman Sachs Asset Management; <https://codebots.com/artificial-intelligence/the-3-types-of-ai-is-the-third-even-possible>. The website links provided are for your convenience only and are not an endorsement or recommendation by Goldman Sachs Asset Management of any of these websites or the products or services offered. Goldman Sachs Asset Management is not responsible for the accuracy and validity of the content of these websites. For illustrative purposes only.

ChatGPT

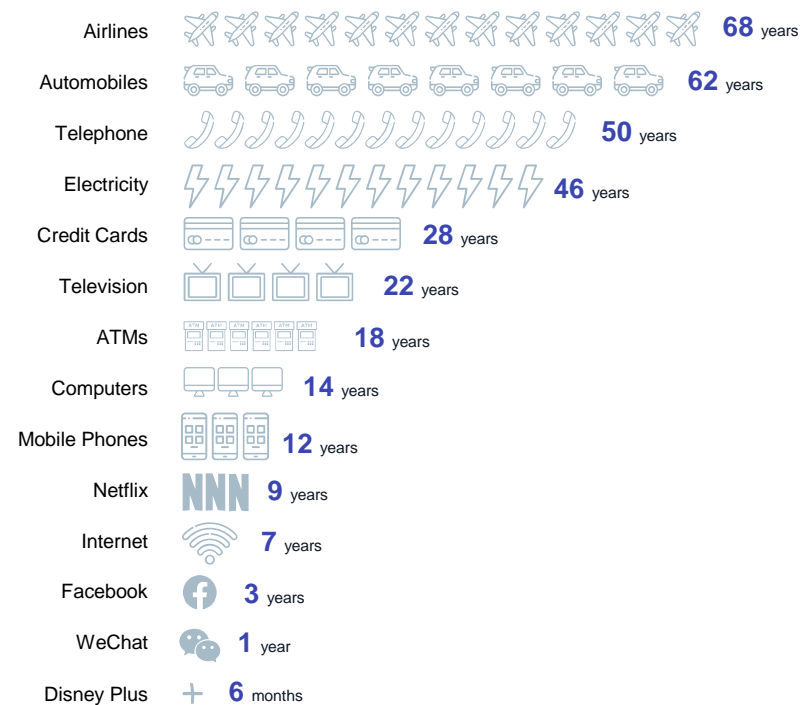
An iPhone Like Moment for the Broader Public?



What is ChatGPT

- ChatGPT is an AI model developed to follow an instruction prompt and then provide a detailed, conversational response.
- The model was trained on huge amounts of data from the internet, meaning that you can ask it nearly anything.
- In 2022, the large-language model developed by OpenAI, took the world by storm, amassing one million users in five days, 50+ million users in one month and then one hundred million users in two months.

Years until 50 Million Users

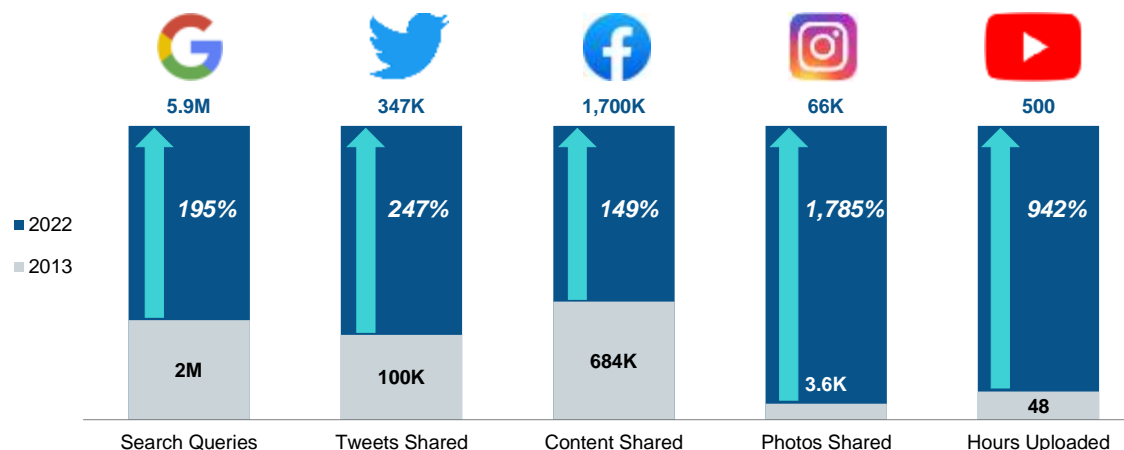
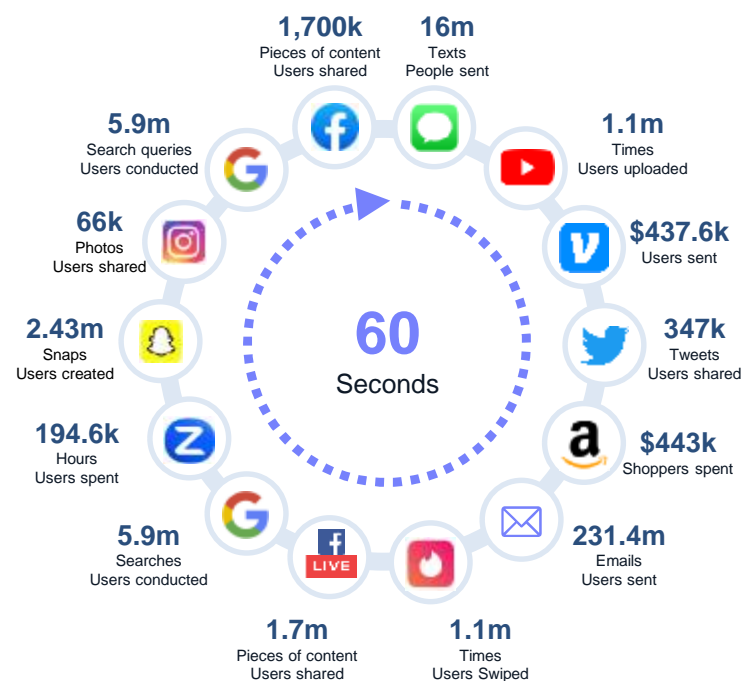


Source: Goldman Sachs Asset Management, OpenAI, Bloomberg and PWC. The economic and market forecasts presented herein are for informational purposes as of the date of this presentation. There can be no assurance that the forecasts will be achieved. Please see additional disclosures at the end of this presentation. Any reference to a specific company or security does not constitute a recommendation to buy, sell, hold or directly invest in the company or its securities.

Growing Data Means Opportunities

The World is Our Oyster, and Data is Our Pearl

DATA NEVER SLEEPS



“ 90 percent of the world’s data was created between 2015 and 2016 alone.”

IBM

“ The big data industry will be worth an estimated \$77bn by 2023.”

Entrepreneur

“ The world is one big data problem.”

Andrew McAfee

“ Data is the new science. Big Data holds the answers.”

Pat Gelsinger

“ 70 percent of investment professionals use “alternative data” or plan to do so in the next year.”

The Hill

“ You can have data without information, but you cannot have information without data.”

Daniel Keys Moran

Source: DOMO. As of 2022. Any reference to a specific company or security does not constitute a recommendation to buy, sell, hold or directly invest in the company or its securities. For illustrative purposes only.

Applications Across Asset Management

Many Technologies and Techniques, and How They Are Used in Our Business

Increased Access To Data

The growth of data and the ability to access it quicker has driven technology developments in data processing and anomaly detection.

Increased Insights Into Trends

- New technology enables us to develop granular and real-time insight at a higher frequency than traditionally possible.
- These datasets can be widely leveraged across business functions within the firm.

Improved Decision Making

- More computationally-intensive analytics allows for deeper insight into the growing set of data to make decisions that further empower investment decision-making, whether it is alpha generative or not.

Improved Productivity

- Whether it's the speed and efficiency in making events decisions, or the automation of time-intensive tasks, technology has improved the output per worker/unit of time.

Source: Goldman Sachs Asset Management. As of September, 2023. For illustrative purposes only.

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Goldman Sachs Asset Management

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Capturing This Opportunity Through Alternative Data

Analysing alternative data gives us an opportunity to leverage the wealth of information to invest better

ALTERNATIVE DATA PLUGS THE “INFORMATIONAL GAP”



Providing Higher Coverage

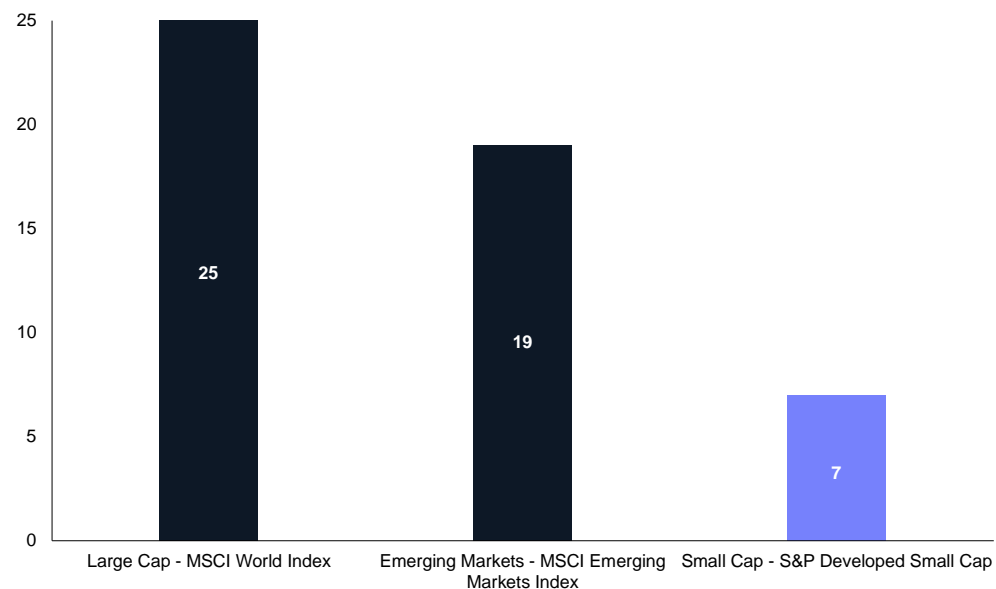
Technology infrastructure allows QIS to form critical investment decisions at scale.

- **150+ signals** (proprietary and managed in-house) in our investment platform
- **1mn datapoints** ingested daily, and processing vast amounts of unstructured textual data

15,000 Global Stocks Analysed Daily

INFORMATIONAL INEFFICIENCIES IN SELECT EQUITY MARKETS

Average Number of Analysts Per Company



Source: MSCI, S&P and Goldman Sachs Asset Management. As of December, 2022. Past performance does not predict future returns and does not guarantee future results, which may vary. For illustration purposes. There is no guarantee that objectives will be met.

Using Technology to Gain Investment Insights

Using Technology to Read Vast Amounts of Text

Analyst Reports

Staying **superior**. While we were by far the **best** performer among our peers in 2020 with ~20% revenue growth (thanks to **superior** financial performance), we still think XYZ is the most **attractive** in terms of valuation pricing.

As Albert Einstein once said, "In the midst of **difficulty** lies **opportunity**"...

We view XYZ's positioning as **inferior**, which puts it in a relatively **worse position** to maintain margin and market share.

News Articles



Earnings Call Transcripts

... First-quarter net income of **\$15 billion** increased **21%** from the prior-year first quarter. Net income of **\$2.4 billion** increased **28%**. Earnings per share were **\$7.25**, up **31%**. The return on common equity was **16.8%**, which is our highest quarterly return in over five years. While pleased with our strong first quarter performance, we step back to put these results and the environment in context...

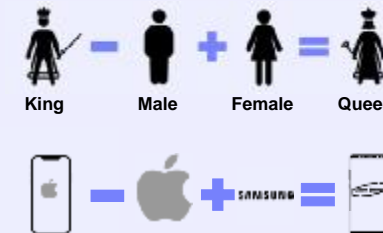
We Can Split the Majority of the Machine Learning Algorithms that we Use to Create Our Investment Signals into Two Categories



Natural Language Processing

$$\begin{bmatrix} 0.7 & -0.1 & 0 & & \\ 1.2 & 0.4 & 1.7 & \dots & 0.8 \\ -0.9 & 0.2 & 0.7 & & \\ \vdots & & & \ddots & \\ 1.2 & & & & -1.7 \end{bmatrix}$$

Dimension Reduction Algorithms



Supplementing well documented and researched quantitative investment process

Source: Goldman Sachs Asset Management. Past performance does not predict future returns and does not guarantee future results, which may vary. For illustrative purposes only, not based on actual results. These data points are some of many that help us make investment decisions.

What Is Needed to Be at the Forefront of Quant Investing

We Enhance Our Time-Tested Investment Philosophy with New Data and Metrics, and Create Technologies Complemented With...

Access to Data



Infrastructure



Expertise



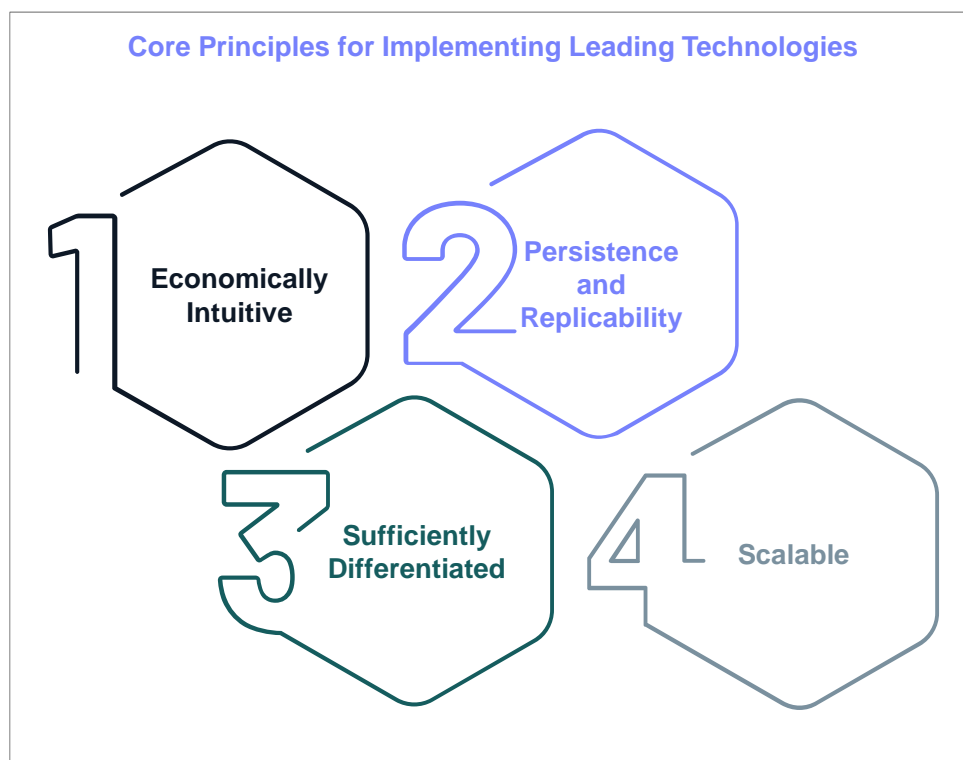
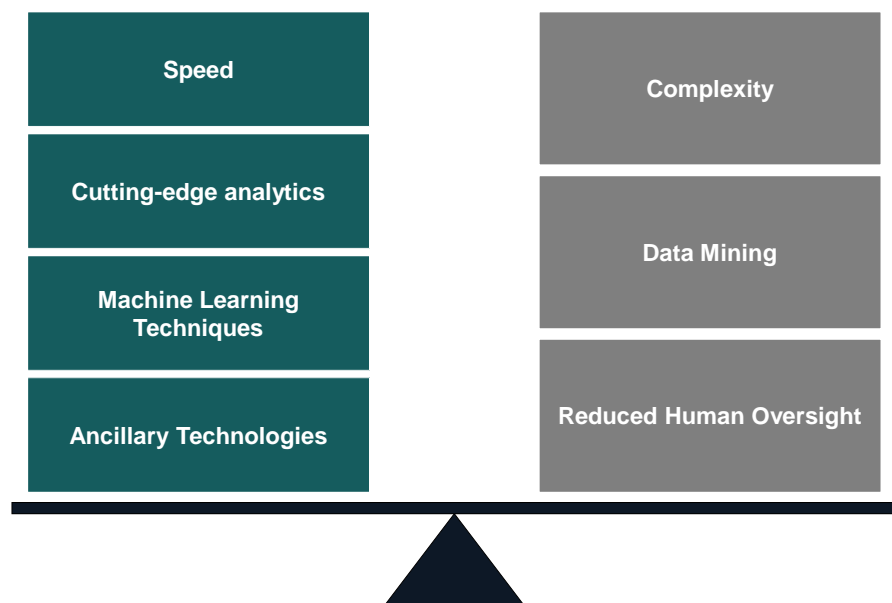
Investment Culture



Source: Goldman Sachs Asset Management. As of September, 2023. For illustrative purposes only.

Balanced Use of Technology

While Technology May Supercharge Our Analysis and Investment Abilities, We Understand the Risks it May Introduce and Seek a Balanced Approach



Source: Goldman Sachs Asset Management. As of September, 2023. There is no guarantee that objectives will be met. For illustrative purposes only.

**Goldman
Sachs**

Asset
Management

The Future

Some New Areas of Research

Important Information

Risk Considerations

Equity investments are subject to market risk, which means that the value of the securities in which it invests may go up or down in response to the prospects of individual companies, particular sectors and/or general economic conditions. Different investment styles (e.g., "growth" and "value") tend to shift in and out of favor, and, at times, the strategy may underperform other strategies that invest in similar asset classes. The market capitalization of a company may also involve greater risks (e.g. "small" or "mid" cap companies) than those associated with larger, more established companies and may be subject to more abrupt or erratic price movements, in addition to lower liquidity.

International securities may be more volatile and less liquid and are subject to the risks of adverse economic or political developments. International securities are subject to greater risk of loss as a result of, but not limited to, the following: inadequate regulations, volatile securities markets, adverse exchange rates, and social, political, military, regulatory, economic or environmental developments, or natural disasters.

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The indices referenced herein have been selected because they are well known, easily recognized by investors, and reflect those indices that the Investment Manager believes, in part based on industry practice, provide a suitable benchmark against which to evaluate the investment or broader market described herein. The exclusion of "failed" or closed hedge funds may mean that each index overstates the performance of hedge funds generally.

References to indices, benchmarks or other measures of relative market performance over a specified period of time are provided for your information only and do not imply that the portfolio will achieve similar results. The index composition may not reflect the manner in which a portfolio is constructed. While an adviser seeks to design a portfolio which reflects appropriate risk and return features, portfolio characteristics may deviate from those of the benchmark.

The portfolio risk management process includes an effort to monitor and manage risk, but should not be confused with and does not imply low risk.

Past performance does not guarantee future results, which may vary. The value of investments and the income derived from investments will fluctuate and can go down as well as up. A loss of principal may occur.

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Important Information (cont'd)

Effect of Fees: The following table provides a simplified example of the effect of management fees on portfolio returns. Assume a portfolio has a steady investment return, gross of fees, of 0.5% per month and total management fees of 0.05% per month of the market value of the portfolio on the last day of the month. Management fees are deducted from the market value of the portfolio on that day. There are no cash flows during the period. The table shows that, assuming all other factors remain constant, the difference increases due to the compounding effect over time. Of course, the magnitude of the difference between gross-of-fee and net-of-fee returns will depend on a variety of factors, and this example is purposely simplified.

Period	Gross Return	Net Return	Differential
1 year	6.17%	5.64%	0.63%
2 years	12.72	11.38	1.34
10 years	81.94	71.39	10.55

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Capital is at risk.

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Goldman Sachs Business Principles

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1. Our clients' interests always come first. Our experience shows that if we serve our clients well, our own success will follow.
 2. Our assets are our people, capital and reputation. If any of these is ever diminished, the last is the most difficult to restore. We are dedicated to complying fully with the letter and spirit of the laws, rules and ethical principles that govern us. Our continued success depends upon unswerving adherence to this standard.
 3. Our goal is to provide superior returns to our shareholders. Profitability is critical to achieving superior returns, building our capital, and attracting and keeping our best people. Significant employee stock ownership aligns the interests of our employees and our shareholders.
 4. We take great pride in the professional quality of our work. We have an uncompromising determination to achieve excellence in everything we undertake. Though we may be involved in a wide variety and heavy volume of activity, we would, if it came to a choice, rather be best than biggest.
 5. We stress creativity and imagination in everything we do. While recognizing that the old way may still be the best way, we constantly strive to find a better solution to a client's problems. We pride ourselves on having pioneered many of the practices and techniques that have become standard in the industry.
 6. We make an unusual effort to identify and recruit the very best person for every job. Although our activities are measured in billions of dollars, we select our people one by one. In a service business, we know that without the best people, we cannot be the best firm.
 7. We offer our people the opportunity to move ahead more rapidly than is possible at most other places. Advancement depends on merit and we have yet to find the limits to the responsibility our best people are able to assume. For us to be successful, our men and women must reflect the diversity of the communities and cultures in which we operate. That means we must attract, retain and motivate people from many backgrounds and perspectives. Being diverse is not optional; it is what we must be.
 8. We stress teamwork in everything we do. While individual creativity is always encouraged, we have found that team effort often produces the best results. We have no room for those who put their personal interests ahead of the interests of the Firm and its clients.
 9. The dedication of our people to the Firm and the intense effort they give their jobs are greater than one finds in most other organizations. We think that this is an important part of our success.
 10. We consider our size an asset that we try hard to preserve. We want to be big enough to undertake the largest project that any of our clients could contemplate, yet small enough to maintain the loyalty, the intimacy and the esprit de corps that we all treasure and that contribute greatly to our success.
 11. We constantly strive to anticipate the rapidly changing needs of our clients and to develop new services to meet those needs. We know that the world of finance will not stand still and that complacency can lead to extinction.
 12. We regularly receive confidential information as part of our normal client relationships. To breach a confidence or to use confidential information improperly or carelessly would be unthinkable.
 13. Our business is highly competitive, and we aggressively seek to expand our client relationships. However, we must always be fair competitors and must never denigrate other firms.
 14. Integrity and honesty are at the heart of our business. We expect our people to maintain high ethical standards in everything they do, both in their work for the firm and in their personal lives.