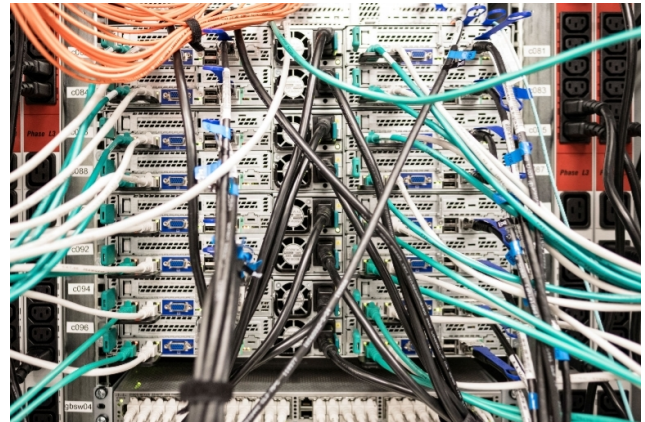


Let's chat about ChatGPT

Information technology

Authors: Kevin Dennean, CFA, CIO Equity Strategist, US Technology & Telecom, UBS Financial Services Inc. (UBS FS); Sundeep Gantori, CFA, CAIA, Equity Strategist, UBS AG Singapore Branch; Delwin Kurnia Limas, CFA, Equity Strategist, UBS AG Singapore Branch; Allen Pu, CFA, Analyst, UBS AG Hong Kong Branch; Reid Gilligan, CIO Equity Strategist, US Media, UBS Financial Services Inc. (UBS FS)

- ChatGPT-3 has captured headlines and generated a mix of excitement and fear among consumers. We view ChatGPT-3 as the current leader in a fast-growing market that will see significant investment and development by leading, large technology companies globally.
- While there are fears of impact on human labor, we think AI tools like ChatGPT will end up as part of the solution in an economy that has more job openings than available workers. Economic history shows that technology ultimately makes productive workers more productive and is net additive to employment and economic growth.
- For more information on investing in AI, please refer to our latest "Investing in the ABCs of tech" update published 6 February 2023. Outside of public equities, investors can also consider opportunities in private equity.



ChatGPT-3 has captured headlines and generated a mix of excitement and fear among consumers. We view ChatGPT-3 as the current leader in a fast growing market that will see significant investment and development by leading, large technology companies globally. Like prior technology developments, we believe artificial intelligence (AI) will ultimately be additive to employment and economic growth. Our "Investing in the ABCs of tech" report focuses on AI, big data, and cybersecurity—three foundational technologies that are at inflection points and should see faster adoption over the next few years as enterprises and governments increase their focus and investments in these areas.

No, this wasn't written by ChatGPT...but it probably could have been

ChatGPT-3 is a chatbot developed by the OpenAI, a US-based artificial intelligence research lab. Many consumers are familiar with chatbots, but less so with the underlying technology. ChatGPT-3 uses a generative pre-trained

transformer (GPT) to generate text that is largely identical to human conversation. GPT is part of the broader family of large language models, which are AI models that understand and can generate text.

Large language models are compelling because of their flexibility. With minimal training, large language models can complete sentences, translate a foreign language, summarize information from multiple sources, and generate content ranging from technical answers to humorous vignettes.

Enormous amounts of data from a range of sources are used in the training process. ChatGPT-3 ingested content from books, academic papers, and the entirety of Wikipedia. According to OpenAI, ChatGPT-3 was trained on over 45 terabytes of data. The system iteratively and without supervision learned to predict the next word in a sequence of text. This unsupervised learning required a network of

This report has been prepared by UBS Financial Services Inc. (UBS FS) and UBS AG Singapore Branch and UBS AG Hong Kong Branch. Please see important disclaimers and disclosures at the end of the document.

distributed computers, which allowed for a faster learning process than could have been accomplished using a single computer. The combination of a vast amount of ingested data and massive computing power resulted in a model with 175 billion parameters, making it one of the largest language models ever created. Parameters in large language models are essentially the values that the model is solving.

Use cases, from the source

Rather than speculate ourselves, we asked ChatGPT for some potential use cases. Here's its response:

"ChatGPT has many potential use cases including chatbots for customer service and mental health support, personal assistants, content creation, language translation, knowledge management, and education/training."

We see ChatGPT as an engine that will eventually power human interactions with computer systems in a familiar, natural, and intuitive way. As ChatGPT stated, large language models can be put to work as a communication engine in a variety of applications across a number of vertical markets.

Glaringly absent in its answer is the use of ChatGPT in search engines. Microsoft, which is an investor in OpenAI, is integrating ChatGPT into its Bing search engine. The use of a large language model enables more complex and more natural searches and extract deeper meaning and better context from source material. This is ultimately expected to deliver more robust and useful results.

Not the only chatbot in town

While ChatGPT has captured press headlines and consumers' enthusiasm, we note that there are a number of other large language models in use at scale today.

- BERT (Bidirectional Encoder Representations from Transformers), developed by Google, is also a transformer-based model that can perform language translation, sentiment analysis, and question-answering.
- T5 (Text-to-Text Transfer Transformer) is another transformer-based language model developed by Google to also provide language translation, summarization, and question-answering.
- XLNet, developed collaboratively by Carnegie Mellon University and Google, is a transformer-based language model that focuses on accurate and coherent responses to text prompts.
- RoBERTa (Robustly Optimized BERT Pre-training Approach), developed by Meta Platforms, is also a transformer-based language model that can provide language translation, question-answering, and text classification.

The latest and the greatest, for now

Is ChatGPT-3 the best large language model (LLM)? It may be so, simply because it is the one of the newest LLMs and therefore benefits from the latest data sources, new AI techniques, and increased computing power at a lower cost. The upshot is that ChatGPT-3 has at least twice as many parameters as its next closest competitors based on publicly available information.

Beyond its powerful capability, we believe one obvious, but underappreciated, reason for the excitement around ChatGPT-3 is simply that it is the first and only LLM that is easily accessible to consumers. The other LLMs noted above are used by consumers and businesses every day, but in less obvious ways as they are integrated into other applications and therefore largely transparent to users.

While ChatGPT-3 seems to be the leading solution today, we believe this is a fast-moving market that will see significant investment and development by all the leading large technology companies globally. We also note that large cloud service providers may have some inherent advantages in that they can offer an integrated solution. Lastly, we think the use of LLMs will only grow from here, broadening their use cases and deepening their integration into a number of applications.

Is AI coming for your job?

Every wave of new and disruptive technology has incited fears of mass job losses due to automation, and we are already seeing those fears expressed relative to AI generally and ChatGPT specifically. The year 1896, when Henry Ford rolled out his first automobile, was probably not a good year for buggy whip makers. When IBM introduced its first mainframe, the System/360, in 1964, office workers feared replacement by mechanical brains that never made mistakes, never called in sick, and never took vacations.

There are certainly historical cases of job displacement due to new technology adoption, and ChatGPT may unseat some office workers or customer service reps. However, we think AI tools broadly will end up as part of the solution in an economy that has more job openings than available workers.

However, economic history shows that technology of any sort (i.e., manufacturing technology, communications technology, information technology) ultimately makes productive workers more productive and is net additive to employment and economic growth.

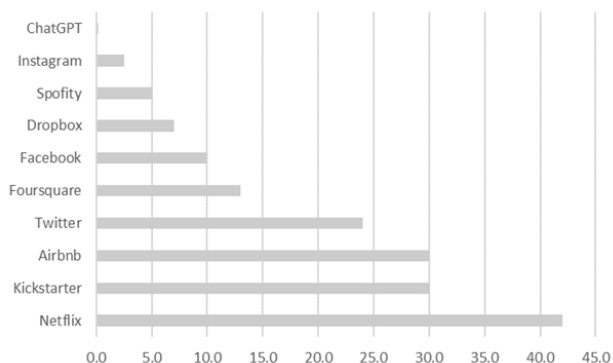
How big is the opportunity?

The broad AI hardware and services market was nearly USD 36bn in 2020, based on IDC and Bloomberg Intelligence data. We expect the market to grow by 20% CAGR to reach USD 90bn by 2025. Given the relatively early monetization

stage of conversational AI, we estimate that the segment accounted for 10% of the broader AI’s addressable market in 2020, predominantly from enterprise and consumer subscriptions. That said, user adoption is rapidly rising. ChatGPT reached its first 1 million user milestone in a week, surpassing Instagram to become the quickest application to do so. Similarly, we see strong interest from enterprises to integrate conversational AI into their existing ecosystem. As a result, we believe conversational AI’s share in the broader AI’s addressable market can climb to 20% by 2025 (USD 18–20bn). Our estimate may prove to be conservative; they could be even higher if conversational AI improvements (in terms of computing power, machine learning, and deep learning capabilities), availability of talent, enterprise adoption, spending from governments, and incentives are stronger than expected.

In addition to higher subscription revenues, we believe advertising potential on AI-generated content (AGC) will become more prevalent. Content generation has seen a remarkably fast-paced transition over the past decade or so. From platform-generated content (in-house content that is often well-executed by content professionals) in the first half of the 2010s to the user-generated content (UGC) era where consumers hold a pivotal role in producing content, leveraging on the effects of peer-to-peer influence. We believe AGC will usher in a new era, with strong use cases on dialogue-based search and AI-generated articles and videos.

Fig. 1: Fast adoption curve for ChatGPT
Months it took to reach 1 million users for each application



Source: Company data, Morgan Stanley, UBS, as of February 2023

How to invest in AI?

We see artificial intelligence as a horizontal technology that will have important use cases across a number of applications and industries. From a broader perspective, AI, along with big data and cybersecurity, forms what we call the ABCs of technology. We believe these three major foundational technologies are at inflection points and should see faster adoption over the next few years as enterprises and governments increase their focus and investments in these areas.

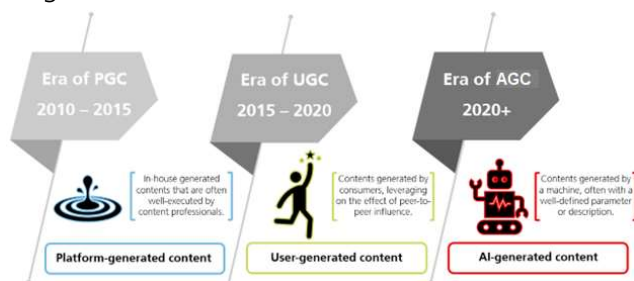
Conversational AI is currently in its early stages of monetization and costs remain high as it is expensive to run. Instead of investing directly in such platforms, interested investors in the short term can consider semiconductor companies, and cloud-service providers that provides the infrastructure needed for generative AI to take off.

In the medium to long term, companies can integrate generative AI to improve margins across industries and sectors, such as within healthcare and traditional manufacturing.

Outside of public equities, investors can also consider opportunities in private equity (PE). We believe the tech sector is currently undergoing a new innovation cycle after 12–18 months of muted activity, which provides interesting and new opportunities that PE can capture through early-stage investments.

For more information on investing in AI, please refer to our latest update “Investing in the ABCs of Tech” published 6 February 2023.

Fig. 2: Decade-long transition toward the era of AI-generated content



Source: UBS, as of February 2023

Non-Traditional Assets

Non-traditional asset classes are alternative investments that include hedge funds, private equity, real estate, and managed futures (collectively, alternative investments). Interests of alternative investment funds are sold only to qualified investors, and only by means of offering documents that include information about the risks, performance and expenses of alternative investment funds, and which clients are urged to read carefully before subscribing and retain. An investment in an alternative investment fund is speculative and involves significant risks. Specifically, these investments (1) are not mutual funds and are not subject to the same regulatory requirements as mutual funds; (2) may have performance that is volatile, and investors may lose all or a substantial amount of their investment; (3) may engage in leverage and other speculative investment practices that may increase the risk of investment loss; (4) are long-term, illiquid investments, there is generally no secondary market for the interests of a fund, and none is expected to develop; (5) interests of alternative investment funds typically will be illiquid and subject to restrictions on transfer; (6) may not be required to provide periodic pricing or valuation information to investors; (7) generally involve complex tax strategies and there may be delays in distributing tax information to investors; (8) are subject to high fees, including management fees and other fees and expenses, all of which will reduce profits.

Interests in alternative investment funds are not deposits or obligations of, or guaranteed or endorsed by, any bank or other insured depository institution, and are not federally insured by the Federal Deposit Insurance Corporation, the Federal Reserve Board, or any other governmental agency. Prospective investors should understand these risks and have the financial ability and willingness to accept them for an extended period of time before making an investment in an alternative investment fund and should consider an alternative investment fund as a supplement to an overall investment program.

In addition to the risks that apply to alternative investments generally, the following are additional risks related to an investment in these strategies:

- **Hedge Fund Risk:** There are risks specifically associated with investing in hedge funds, which may include risks associated with investing in short sales, options, small-cap stocks, "junk bonds," derivatives, distressed securities, non-U.S. securities and illiquid investments.
- **Managed Futures:** There are risks specifically associated with investing in managed futures programs. For example, not all managers focus on all strategies at all times, and managed futures strategies may have material directional elements.
- **Real Estate:** There are risks specifically associated with investing in real estate products and real estate investment trusts. They involve risks associated with debt, adverse changes in general economic or local market conditions, changes in governmental, tax, real estate and zoning laws or regulations, risks associated with capital calls and, for some real estate products, the risks associated with the ability to qualify for favorable treatment under the federal tax laws.
- **Private Equity:** There are risks specifically associated with investing in private equity. Capital calls can be made on short notice, and the failure to meet capital calls can result in significant adverse consequences including, but not limited to, a total loss of investment.
- **Foreign Exchange/Currency Risk:** Investors in securities of issuers located outside of the United States should be aware that even for securities denominated in U.S. dollars, changes in the exchange rate between the U.S. dollar and the issuer's "home" currency can have unexpected effects on the market value and liquidity of those securities. Those securities may also be affected by other risks (such as political, economic or regulatory changes) that may not be readily known to a U.S. investor.

UBS Chief Investment Office's ("CIO") investment views are prepared and published by the Global Wealth Management business of UBS Switzerland AG (regulated by FINMA in Switzerland) or its affiliates ("UBS").

The investment views have been prepared in accordance with legal requirements designed to promote the **independence of investment research**.

Generic investment research – Risk information:

This publication is **for your information only** and is not intended as an offer, or a solicitation of an offer, to buy or sell any investment or other specific product. The analysis contained herein does not constitute a personal recommendation or take into account the particular investment objectives, investment strategies, financial situation and needs of any specific recipient. It is based on numerous assumptions. Different assumptions could result in materially different results. Certain services and products are subject to legal restrictions and cannot be offered worldwide on an unrestricted basis and/or may not be eligible for sale to all investors. All information and opinions expressed in this document were obtained from sources believed to be reliable and in good faith, but no representation or warranty, express or implied, is made as to its accuracy or completeness (other than disclosures relating to UBS). All information and opinions as well as any forecasts, estimates and market prices indicated are current as of the date of this report, and are subject to change without notice. Opinions expressed herein may differ or be contrary to those expressed by other business areas or divisions of UBS as a result of using different assumptions and/or criteria.

In no circumstances may this document or any of the information (including any forecast, value, index or other calculated amount ("Values")) be used for any of the following purposes (i) valuation or accounting purposes; (ii) to determine the amounts due or payable, the price or the value of any financial instrument or financial contract; or (iii) to measure the performance of any financial instrument including, without limitation, for the purpose of tracking the return or performance of any Value or of defining the asset allocation of portfolio or of computing performance fees. By receiving this document and the information you will be deemed to represent and warrant to UBS that you will not use this document or otherwise rely on any of the information for any of the above purposes. UBS and any of its directors or employees may be entitled at any time to hold long or short positions in investment instruments referred to herein, carry out transactions involving relevant investment instruments in the capacity of principal or agent, or provide any other services or have officers, who serve as directors, either to/for the issuer, the investment instrument itself or to/for any company commercially or financially affiliated to such issuers. At any time, investment decisions (including whether to buy, sell or hold securities) made by UBS and its employees may differ from or be contrary to the opinions expressed in UBS research publications. Some investments may not be readily realizable since the market in the securities is illiquid and therefore valuing the investment and identifying the risk to which you are exposed may be difficult to quantify. UBS relies on information barriers to control the flow of information contained in one or more areas within UBS, into other areas, units, divisions or affiliates of UBS. Futures and options trading is not suitable for every investor as there is a substantial risk of loss, and losses in excess of an initial investment may occur. Past performance of an investment is no guarantee for its future performance. Additional information will be made available upon request. Some investments may be subject to sudden and large falls in value and on realization you may receive back less than you invested or may be required to pay more. Changes in foreign exchange rates may have an adverse effect on the price, value or income of an investment. The analyst(s) responsible for the preparation of this report may interact with trading desk personnel, sales personnel and other constituencies for the purpose of gathering, synthesizing and interpreting market information.

Tax treatment depends on the individual circumstances and may be subject to change in the future. UBS does not provide legal or tax advice and makes no representations as to the tax treatment of assets or the investment returns thereon both in general or with reference to specific client's circumstances and needs. We are of necessity unable to take into account the particular investment objectives, financial situation and needs of our individual clients and we would recommend that you take financial and/or tax advice as to the implications (including tax) of investing in any of the products mentioned herein.

This material may not be reproduced or copies circulated without prior authority of UBS. Unless otherwise agreed in writing UBS expressly prohibits the distribution and transfer of this material to third parties for any reason. UBS accepts no liability whatsoever for any claims or lawsuits from any third parties arising from the use or distribution of this material. This report is for distribution only under such circumstances as may be permitted by applicable law. For information on the ways in which CIO manages conflicts and maintains independence of its investment views and publication offering, and research and rating methodologies, please visit www.ubs.com/research-methodology. Additional information on the relevant authors of this publication and other CIO publication(s) referenced in this report; and copies of any past reports on this topic; are available upon request from your client advisor.

Options and futures are not suitable for all investors, and trading in these instruments is considered risky and may be appropriate only for sophisticated investors. Prior to buying or selling an option, and for the complete risks relating to options, you must receive a copy of "Characteristics and Risks of Standardized Options". You may read the document at <https://www.theocc.com/about/publications/character-risks.jsp> or ask your financial advisor for a copy.

Investing in structured investments involves significant risks. For a detailed discussion of the risks involved in investing in any particular structured investment, you must read the relevant offering materials for that investment. Structured investments are unsecured obligations of a particular issuer with returns linked to the performance of an underlying asset. Depending on the terms of the investment, investors could lose all or a substantial portion of their investment based on the performance of the underlying asset. Investors could also lose their entire investment if the issuer becomes insolvent. UBS does not guarantee in any way the obligations or the financial condition of any issuer or the accuracy of any financial information provided by any issuer. Structured investments are not traditional investments and investing in a structured investment is not equivalent to investing directly in the underlying asset. Structured investments may have limited or no liquidity, and investors should be prepared to hold their investment to maturity. The return of structured investments may be limited by a maximum gain, participation rate or other feature. Structured investments may include call features and, if a structured investment is called early, investors would not earn any further return and may not be able to reinvest in similar investments with similar terms. Structured investments include costs and fees which are generally embedded in the price of the investment. The tax treatment of a structured investment may be complex and may differ from a direct investment in the underlying asset. UBS and its employees do not provide tax advice. Investors should consult their own tax advisor about their own tax situation before investing in any securities.

Important Information About Sustainable Investing Strategies: Sustainable investing strategies aim to consider and incorporate environmental, social and governance (ESG) factors into investment process and portfolio construction. Strategies across geographies and styles approach ESG analysis and incorporate the findings in a variety of ways. Incorporating ESG factors or Sustainable Investing considerations may inhibit the portfolio manager's ability to participate in certain investment opportunities that otherwise would be consistent with its investment objective and other principal investment strategies. The returns on a portfolio consisting primarily of sustainable investments may be lower or higher than portfolios where ESG factors, exclusions, or other sustainability issues are not considered by the portfolio manager, and the investment opportunities available to such portfolios may differ. Companies may not necessarily meet high performance standards on all aspects of ESG

or sustainable investing issues; there is also no guarantee that any company will meet expectations in connection with corporate responsibility, sustainability, and/or impact performance.

External Asset Managers / External Financial Consultants: In case this research or publication is provided to an External Asset Manager or an External Financial Consultant, UBS expressly prohibits that it is redistributed by the External Asset Manager or the External Financial Consultant and is made available to their clients and/or third parties.

USA: Distributed to US persons by UBS Financial Services Inc. or UBS Securities LLC, subsidiaries of UBS AG. UBS Switzerland AG, UBS Europe SE, UBS Bank, S.A., UBS Brasil Administradora de Valores Mobiliarios Ltda, UBS Asesores Mexico, S.A. de C.V., UBS SuMi TRUST Wealth Management Co., Ltd., UBS Wealth Management Israel Ltd and UBS Menkul Degerler AS are affiliates of UBS AG. **UBS Financial Services Inc. accepts responsibility for the content of a report prepared by a non-US affiliate when it distributes reports to US persons. All transactions by a US person in the securities mentioned in this report should be effected through a US-registered broker dealer affiliated with UBS, and not through a non-US affiliate. The contents of this report have not been and will not be approved by any securities or investment authority in the United States or elsewhere. UBS Financial Services Inc. is not acting as a municipal advisor to any municipal entity or obligated person within the meaning of Section 15B of the Securities Exchange Act (the "Municipal Advisor Rule") and the opinions or views contained herein are not intended to be, and do not constitute, advice within the meaning of the Municipal Advisor Rule**

For country information, please visit ubs.com/cio-country-disclaimer-gr or ask your client advisor for the full disclaimer.

Version A/2023. CIO82652744

© UBS 2023. The key symbol and UBS are among the registered and unregistered trademarks of UBS. All rights reserved.