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EMERGING TECH RESEARCH

Emerging Tech Future Report: Updating Our Generative AI Outlook

Models thrive while complexity, costs impact applications

PitchBook is a Morningstar company providing the most comprehensive, most accurate, and hard-to-find data for professionals doing business in the private markets.

Introduction

In May 2023, our team published perspectives on how Generative AI (GenAI) was poised to impact various industries and technologies. This note revisits those perspectives with fresh takes on how GenAI is (or is not) manifesting itself and how expectations have changed or evolved.

The rise of ChatGPT in early 2023 was a pivotal moment, marking the point when AI became understood as an easily adaptable technology with the potential for broad application. Since then, investment in related technologies and startups has skyrocketed, highlighted by intense competition in the foundation model space as new startups and technology incumbents have aggressively jumped into the fray.

The GenAI-infrastructure landscape is stratifying across several use cases, such as on-device inference, domain-specific knowledge, and simply raw power to produce the best results the fastest. Some form factors, such as general consumer search and chatbots, have emerged as battlegrounds for tech giants like Google and Meta as they seek to keep users within their ecosystems. Other strategies include more specialized applications, such as personal assistants for enterprise use cases and software development.

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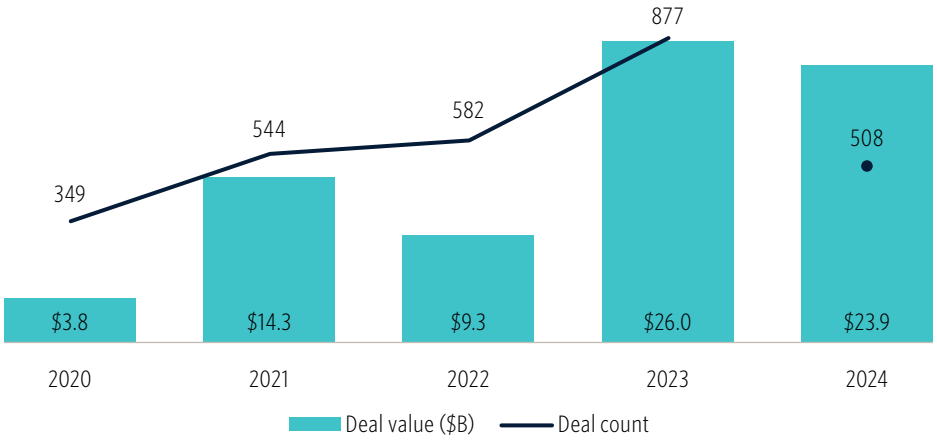
However, as our analysts describe in this note, several blockers to adoption remain despite intensified efforts toward AI transformation. These include high compute costs, data availability, data security, and overall system complexity. Whereas much progress has been made at the foundation model level, where investment capital appears endless, application-level startups face a more challenging fundraising environment as they feel near-term pressures to demonstrate commercial viability.

GenAI software spending estimate ($B)

Source: IDC • Geography: Global • As of August 20, 2024

GenAI VC deal activity



Source: PitchBook • Geography: Global • As of August 20, 2024

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Enterprise applications

AI & ML

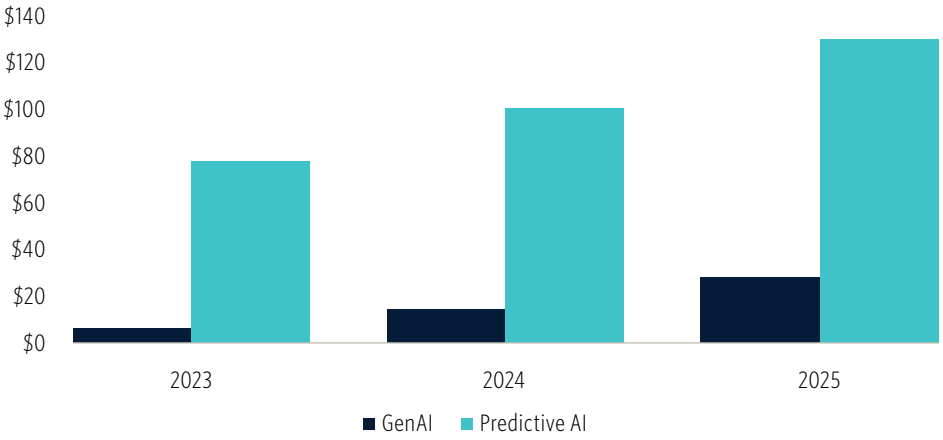
Prior expected impacts

At the outset of GenAI's irruption, we saw the limitations of large language models (LLMs) for enterprise use cases and early signs of trends that are now maturing. Expected innovations included the maturation of a supporting LLM operations (LLMOps) industry, including foundation model orchestration and vector search, along with AI agents. The need for supporting software for LLMs has been exacerbated by the limitations of successive model releases after OpenAI's GPT-4 and the proliferation of copycat open-source models, requiring users to get higher-quality outputs from similar generative models. In the long term, we expected foundation models to create more decacorns valued at over $10.0 billion and code generation to progress the field to a greater extent than image generation or chatbots.

Reality one year later

GenAI has transformed the existing AI & machine learning (ML) vertical in fundamental yet still limited ways. While new LLMs represent the future of the industry, they have not extinguished legacy approaches, and pre-existing models still outnumber LLM applications. GenAI software will contribute only about 14% of AI software spending in 2024 with $14.5 billion and is on pace to contribute only 32.3% of spending by 2028, according to IDC estimates.[1] Even so, companies building legacy ML models have seen their estimated valuations plunge, including DataRobot's by over 90% and H20.ai's by over 80% in the face of GenAI disruption.[2] New research into model techniques can further progress the field in deterministic areas of software, as covered in our analyst note on foundation models. LLM innovators are capturing mindshare and market share from their predictive predecessors.

AI-centric software spending estimate by type ($B)



Source: IDC • Geography: Global • As of August 20, 2024

1: "Worldwide AI and Generative AI Spending Guide," IDC, Karen Massey, et al., August 20, 2024.
2: "Caplight MarketPrice," Caplight, August 28, 2024.

Enterprise rollouts have progressed more slowly than initially forecast, and models have not continued to take on new capabilities. Because of the tepid adoption of applications, the infrastructure layer, including model architecture labs and semiconductor startups, has achieved 25 of the 39 unicorn valuations we have tracked in the LLMOps space. Semiconductors, model research labs, and startup cloud providers have shown the need for a new stack and have demonstrated the ability to create new software innovations without a significant surrounding ecosystem. We did not anticipate the demand for startup cloud providers that have achieved high valuations, including CoreWeave, Crusoe, Lambda, and Together AI. New semiconductors have achieved breakthroughs in LLM inference and datacenter networking, building on the NVIDIA GPU ecosystem, including those of Astera Labs, Cerebras, and Groq.

Other software categories face challenges to prove their legitimacy. We tracked a doubling of VC deal count for GenAI operations software in 2023, including in data preparation, model orchestration, and application deployment, and 2024 is on pace for a further 50% growth. Deal value has not kept up with the infrastructure layer, however. These LLMops companies have not grown large independently, given the spectrum of configuration options and continuously improving features from hyperscalers. Vector databases in particular have become commoditized and are unlikely to present a growth category as open-source options extend their network effects and incumbent databases offer vector support. The AI agent space has become crowded, yet we believe it will be disrupted by more action-oriented model capabilities. Few acquisitions of model orchestration companies have been made to justify early-stage VC investments as acquirers monitor the monetization of LLM tools.

PitchBook users can access a full list of AI agent startups here.

Real-world progress

In the long term, commercial gains will likely come before artificial general intelligence (AGI) potentially renders software irrelevant. Incumbents have taken more commanding positions than was clear last year via aggressive startup investments. We predicted that more $10.0 billion companies would be created after OpenAI, which has proven true with Anthropic, CoreWeave, and Scale AI, yet other contenders have fallen short of that total before succumbing to Big Tech offers, including Adept AI, Character.AI, and Inflection AI. AI in software development has accelerated to widespread adoption, with large customers relying on AI code generation. Coding assistant startups raised over $1.0 billion in H1 2024 after raising only $480.6 million in 2023, showing the success of the technology and scale of the market. Generative media lags expectations, facing VC funding declines in multimedia content suites and video generation. Vertical-focused companies face accusations of vaporware as they align general-purpose LLMs with customer workflows and occasionally wait for base models to improve before their products do.

Key recent GenAI VC exits and talent acquisitions

Company	Close date (2024)	Segment	Category	Exit value ($M)	Acquirer
Character.AI	August 22	AI core	Model architecture	$2,500.0	Alphabet
Adept AI	June 28	AI core	Model architecture	N/A	Amazon
Clickable	June 26	Visual media	Content suite	N/A	Beehiiv
Argilla	June 13	AI core	Model architecture	N/A	Hugging Face
Uizard	May 24	Code	Testing	N/A	Miro
Deci	May 2	AI core	Deployment	$300.0	NVIDIA
Mirage	April 8	Visual media	3D models	N/A	Harvey
PartyKit	April 4	AI core	Orchestration	N/A	Cloudflare
Inflection AI	March 21	AI core	Model architecture	$650.0	Microsoft
DarwinAI	January 1	Vertical applications	Industrial	N/A	Apple

Source: PitchBook • Geography: Global • As of June 30, 2024

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Crypto

Prior expected impacts

A year ago, the anticipated impacts of AI within the crypto space were seen as potentially transformative, especially with the rapid rise of GenAI. It was expected that AI would significantly enhance smart contract development and auditing, particularly through tools such as OpenAI's ChatGPT and GitHub's Copilot. AI's ability to write and debug code in languages such as Solidity, Vyper, and Move was projected to democratize smart contract creation, making it accessible to a broader range of developers. Additionally, AI was expected to simplify blockchain data querying, a task that is notoriously complex even with tools such as Etherscan and The Graph. ChatGPT's natural language processing capabilities were predicted to allow users to ask straightforward questions about blockchain data, thus making data more accessible to nontechnical users.

Another anticipated impact was in the area of protocol and tokenomics documentation. Many crypto projects require extensive documentation, and AI was expected to streamline this process by generating white papers, technical guides, and other necessary documentation. AI's role in market analysis and trading was also anticipated to be significant, with expectations that AI would analyze market trends, on-chain activities, and sentiment from various sources, aiding in better-informed investment decisions. Moreover, there was a belief that decentralized infrastructure could benefit from AI, as blockchain technology could facilitate the decentralized training of AI models, leading to transparent and trustless versions of LLMs.

As AI technology became cheaper and more powerful, the winners in this space were expected to be large, well-established crypto platforms and projects with substantial data resources and the ability to invest in AI integration. Smaller or less-well-funded projects were seen as potential losers unless they could leverage AI through third-party platforms or form strategic partnerships.

Reality one year later

A year later, some of the expected impacts of AI on the crypto space are materializing, albeit with varying degrees of success. AI has started to play a role in smart contract development and auditing, but adoption has been slow, likely because developers are still used to working with older tools. Also, while AI tools have shown promise in writing and debugging smart contract code, the complexity of crypto-specific languages and the need for human oversight have tempered the pace of adoption.

Progress has been more pronounced in blockchain data querying. AI-driven tools are beginning to simplify the process of accessing and interpreting blockchain data. However, widespread adoption is still hindered by the need for greater integration with existing platforms and the ongoing challenges of ensuring data accuracy and reliability.

One of the more surprising developments has been the explosion of startups using blockchain technology to build decentralized AI (DeAI). Crypto can serve as a counterbalance to the increasingly centralized and opaque nature of AI. While AI models such as GPT-4 and Claude 3 are permissioned and controlled by a few entities, the crypto ecosystem offers a permissionless, transparent, and decentralized alternative. This dynamic opens up unique use cases where crypto and AI intersect, such as enabling AI agents to autonomously perform tasks and exchange value within decentralized networks.

Crypto can also act as an incentive and control mechanism for the data used to train AI models, ensuring greater transparency and fairness in data usage. Additionally, decentralized computing systems powered by crypto could democratize access to AI hardware, making advanced computational resources more broadly available and reducing the barriers to AI innovation. While the concept of decentralized AI training and inference remains compelling, practical implementation has proven difficult, largely due to the technical and logistical challenges of distributing training processes across a decentralized network.

Real-world progress

Blockchain development platform Alchemy launched ChatWeb3, a tool designed to provide developers with a conversational interface for interacting with blockchain data and smart contracts. It allows users to ask natural language questions about blockchain transactions, smart contract states, and other Web3-related data, making it easier to retrieve and analyze information without needing to write complex queries or code. The Graph released a road map that shows its plans to introduce advanced AI-driven tools and features that enhance the indexing and querying of blockchain data. This advancement could directly support smart contract development by making it easier to retrieve blockchain data, analyze it, and integrate it into smart contracts, enabling more sophisticated and data-driven contract functionalities.

There has been quite a lot of focus on decentralizing AI development, with crypto used as the incentivizing mechanism for development contribution. For instance, Sentient raised an $85.0 million seed round in July 2024 to create an open AI economy where developers and creators can collaborate, monetize their AI models, and participate in the development of AGI. Sentient's platform utilizes blockchain protocols to ensure economic alignment and compensate creators for their AI models. Sahara AI, which raised a $43.0 million Series A in August 2024, is a similar company that is building a blockchain-based platform that ensures transparent ownership, governance, and compensation for AI assets. Key components of the platform include an AI-native blockchain, a DeAI marketplace, development tools, and secure storage solutions. The platform aims to provide a collaborative environment where contributors can securely create, share, and trade AI models and data.

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Data analytics

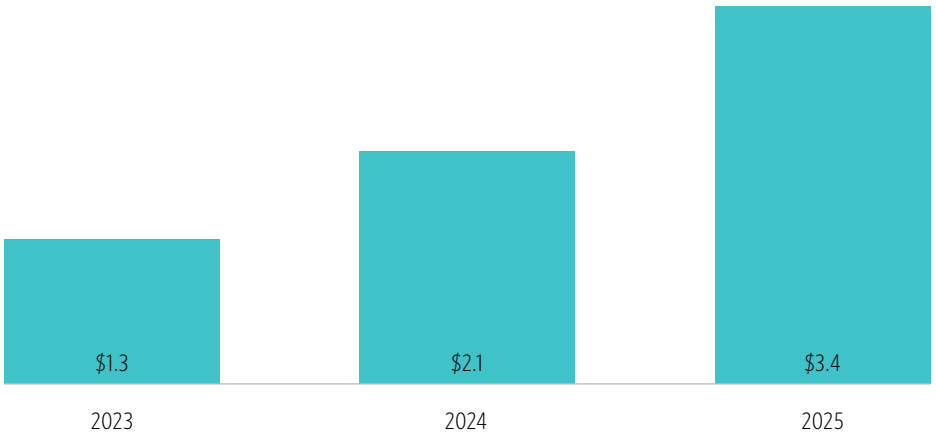
Prior expected impacts

Our note last year covered GenAI's implications in Internet of Things (IoT). Since then, we have transitioned our IoT coverage to data analytics to better reflect the technologies making an impact in industrial settings. Our data analytics launch report laid out the initial applications of GenAI in the vertical, including Structured Query Language (SQL) generation, data transformation, and business intelligence visualization. These use cases apply to industrial contexts as well, with startups building custom AI models to analyze domain-specific datasets with customized query languages. Quantitative data analysis did not initially stand out as a leading use case for LLMs due to their training on internet text. Early demonstrations such as OpenAI's Code Interpreter showed the potential for LLMs to learn data schemata and produce visualizations, yet models lacked reliability in answering data-driven questions with complex queries.

Reality one year later

While most analytics software does not depend on GenAI, we estimate that $2.1 billion will be spent on GenAI-native analytics & business intelligence software in 2024, growing 61.6% from 2023. This growth slightly lags the rest of the market, including that of other use cases such as customer service and software development. The estimate reflects a small but growing proportion of spending on GenAI in the data analytics industry that will approach 10% this year. We have looked for evidence of more business users engaging with their data via GenAI interfaces to show if the technology can have a democratizing effect. In practice, even leading LLMs struggle to achieve accurate outputs in structured data analysis tasks, with the best model surpassing a 56% average for tasks including SQL joins, data annotation, and table reformatting.[3] As a result, specialist data scientists are still required to manually review analytics code, limiting the volume of business users that can interact with advanced frameworks.

GenAI spending estimate in analytics & business intelligence ($B)



Source: PitchBook • Geography: Global • As of June 30, 2024

3: "A Challenging, Contamination-Free LLM Benchmark," LiveBench, Colin White, et al., July 25, 2024.

Not all database companies benefit from GenAI adoption, with customers going directly to model providers and adopting fit-for-purpose open-source solutions. Leading public database companies including Elastic, MongoDB, and Snowflake have faced declining growth during the GenAI boom, even as they add GenAI features and invest in GenAI startups. Snowflake's new CEO Sridhar Ramaswamy has a GenAI background, but the company has seen low usage of its new AI product offerings. Conversely, VC-backed Databricks has seen growth reaccelerate as the company launches custom AI training solutions, and Palantir Technologies' commercial segment has accelerated as well. Databricks attributes some of this growth to GenAI usage, noting 210% growth in the number of companies registering at least one AI model and 1,018% growth in the volume of distinct AI models in the company's platform overall in 2024.[4] We have long believed that Databricks has a more comprehensive AI strategy than Snowflake, and Databricks is now likely to surpass Snowflake in revenue.

Real-world progress

GenAI has proven to have varying benefits based on the type of dataset analyzed. All database vendors are launching vector support to work with unstructured language data for retrieval-augmented generation. In one recent comparative survey of IT users, 31.1% of product analytics users said they actively utilize GenAI, but only 22.1% of customer data platform users said they did so.[5] Product analytics platforms actively integrate AI chatbots to ask questions about usage data, while customer data platforms still face adoption barriers around privacy and accuracy. Industrial customers are lagging in GenAI adoption by every measure because tabular data from machine sensors does not easily integrate with LLMs, compounding a lack of data science sophistication in industrial organizations. According to a McKinsey survey, GenAI is widely used at only 6% of supply chain organizations and 4% of manufacturing organizations.[6] LLMs can struggle to extract quantitative answers from time series data, and configuring them does not align with the skill sets of operational staff. Startups have not grown large independently in this niche.

PitchBook users can view the full list of GenAI data science coding startups here.

Startups focusing exclusively on GenAI data analytics have grown numerous but are not raising large rounds to match; in H1 2024, only $29.0 million was raised across 11 deals for a cohort of 85 companies. This sum pales in comparison to more general-purpose coding assistants that can help data analysts write Python code. In practice, the coding startups we have met with are interested in producing models to write general-purpose Python code instead of specializing in data-specific query languages. Many data scientists are content to work with native LLM provider capabilities such as those of OpenAI's Code Interpreter and Claude's Artifacts. Even so, leading VC investors have placed concentrated bets in the data science space with expectations for disruption, and database leaders have proven to be willing acquirers at an early stage. As startups look to grow into large companies, the leadership of hyperscalers in data analytics creates barriers to entry for new products that may require successive versions of GenAI models to overcome.

4: "State of Data+AI: Data Intelligence and the Race to Customize LLMs," Databricks, May 29, 2024.
5: "IDC CX Path: Executive Summary, 2024 — Examining the CX Buyer's Journey," IDC, Nadia Ballard, et al., August 5, 2024.
6: "The State of AI in Early 2024: GenAI Adoption Spikes and Starts to Generate Value," QuantumBlack, AI by McKinsey, Alex Singla, et al., May 30, 2024.

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Enterprise SaaS

Prior expected impacts

We previously anticipated that LLMs would have a major impact on general research and content creation, as well as revolutionize enterprise search and democratize generative design for architecture, manufacturing, and production solutions.

We also expected greater investment in virtual agents to potentially commandeer numerous customer relationship management channels, though the potential for "hallucinations" and other possible mistakes could induce steep and difficult-to-anticipate costs.

Finally, we flagged the potential for greater concentrations of power in major foundation models and their developers, especially as their resource intensity increased.

Reality one year later

Many of these predictions have come to pass. Many AI-driven solutions have been developed across content creation, general and enterprise research, and generative design and manufacturing.

AI-driven solutions have moved forward with blinding speed as numerous startups have used these technologies to pursue opportunities identified as low-hanging fruit. This has created something of a stampede as numerous startups pursue similar solutions, most notably Hugging Face, Kore.ai, and Ada.

One notable and positive surprise has been the incredibly quick decline in reported hallucinations and similar mistakes. Although these were widely reported in the initial wave of LLMs, they appear to be significantly less frequent in more recent models. We believe that human users are also much more observant of their occurrence and thus may remediate these issues when they appear.

Although enterprise adoption is widespread, we believe that traditional cost concerns are restraining investments. Outside of a few obvious integrations (such as more intelligent chatbots), we believe that many enterprises have taken a "wait and see" approach as today's startups continue to develop their offerings.

Real-world progress

There has been much progress in the realms of conversational AI as well as the supplemental technology of emotion AI. Conversational AI systems are developed to understand and respond to user queries, requests, or commands in a manner that mimics human conversation.

Conversational AI has been supported by developments in emotion AI software and systems that detect, interpret, and respond to human emotions, which promise to develop greater human-machine connections and potentially human-human connections.

Conversational AI can be found in various applications, such as chatbots, voice-controlled interfaces, and virtual assistants. Examples of incumbent deployment of conversational AI solutions include Open AI's ChatGPT, Google Duplex, Microsoft Bot Framework, Azure AI Bot Service, IBM Watson, Samsung's Bixby, and Salesforce Einstein. These incumbents have all developed emotion AI solutions as well.

Startups in conversational AI include Hugging Face, Kore.ai, Ada, ASAPP, Cresta, and Yellow.ai. Emotion AI startups include Uniphore, Entropik, Realeyes, MorphCast, Voicesense, Superceed, audEERING, and Opsis.

Select conversational AI startups

Company	VC ($M) raised to date	Segment	Category	IPO probability	M&A probability	No exit probability
ASAPP	$312.6	Customer relationship management	Customer service & support	56%	39%	5%
Kore.ai	$266.1	Customer relationship management	Customer service & support	48%	49%	3%
Cresta	$156.0	Customer relationship management	Customer service & support	41%	55%	4%
Ada	$16.2	Customer relationship management	Customer service & support	33%	62%	5%
Superceed	$5.0	Customer relationship management	Customer service & support	1%	21%	78%
Yellow.ai	$4.7	Customer relationship management	Customer service & support	31%	60%	9%
Entropik	$0.2	Customer relationship management	Marketing	7%	89%	4%

Source: PitchBook • Geography: Global • As of June 30, 2024
Note: Probability data is based on PitchBook VC Exit Predictor methodology.

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Fintech

Prior expected impacts

In 2023, both fintech companies and financial institutions (FIs) quickly turned their attention toward exploring the potential of innovating with GenAI. During this initial phase in the hype cycle, we noted that banks and FIs would be slow to deploy GenAI-powered products given their meticulous research & development (R&D) processes and strict regulatory requirements. We anticipated that GenAI would primarily be used to create operational efficiencies, enhancing functions such as customer support, code completion, and manual document reviews. One use case we were particularly excited about was the potential for greater hyperpersonalization, though we expected near-term deployment to be limited.

Reality one year later

Over the past year, we have observed sustained interest in GenAI innovation from fintech companies and FIs. Generally, fintech companies have been quicker to deploy GenAI-based products, while incumbent FIs and banks have proceeded more cautiously, aligning with our expectations. Areas where we have seen strong employment of AI include lending, banking, wealthtech, and regulation technology. In these subsectors, GenAI has been utilized to improve operational excellence, enhance datasets, streamline customer service, automate manual tasks, and personalize product offerings. However, many GenAI applications still remain in early innings, with their true return on investment yet to be determined.

Meanwhile, incumbents have seen significantly slower deployment of GenAI applications than fintech startups, but they should not be counted out. Larger players and incumbents have the resources to conduct extensive R&D experiments and typically possess the expertise to comply with regulations. For instance, Discover has several pending patents on explainable AI methods and AI applications for fair lending. Additionally, banks also own large and rich datasets that can be used to train robust models. Large banks such as J.P. Morgan, Goldman Sachs, and Morgan Stanley have embraced GenAI innovation.

The rapid emergence of GenAI in fintech has also prompted some strategic acquisitions. One of the earliest examples we saw was from Ramp, which acquired Cohere.io in May 2023 to enhance AI customer support functions and add talent in AI. In August 2023, Ramp made another talent acquisition play by purchasing AI-procurement startup Venue. We also saw Brightflow AI acquire data intelligence startup CircleUp in June 2023 to offer its small and medium-size business customers AI-powered financial insights. M&A has additionally been used to bolster

hyperpersonalization capabilities. In January 2024, ABAKA was acquired by ieDigital to enhance the company's ML engine and analytical capabilities. Similarly, in June 2024, Nubank bought seed-stage data startup Hyperplane, which uses proprietary foundation models and allows FIs to train and deploy their own learning models. Though fintech M&A has been soft due to capital constraints, we expect a lower-interest-rate environment may spur more AI acquisition activity.

Real-world progress

Most applications of GenAI continue to be centered around driving efficiencies and operational excellence, which has been realized primarily through automative tools, chatbots, and AI agents. Examples from startups include:

- Klarna's OpenAI-powered chatbot, which the company claims can deliver the same work output as 700 of its full-time agents and has improved its bottom line by $40.0 million in 2024.[7]

- Worth AI's AI-powered business underwriting platform, which secured $12.0 million in seed funding in Q4 2023.

- bunq's GenAI-powered assistant Finn, which allows its banking customers to ask questions and obtain insights regarding their finances.

- MoneyLion's GenAI-powered search engine, which will allow consumers to ask questions and analyze their finances. The search engine is currently being tested in a beta stage and is expected to launch by the end of summer 2024.

- Parthean's AI-powered assistant for personal financial management, which helps users analyze finances, save money, and plan for future spending.

- Cascading AI's digital assistant, which helps guide small businesses through loan applications and reduce application churn rates.

Notably, fraud detection and compliance automation are common areas where AI is being leveraged. Notable examples include:

- Unit21's AI-powered case-management and data-analysis system and AI copilot designed to enhance transaction monitoring functions.

- Themis' AI chatbot, which supports users on its anti-money-laundering platform.

7: "Klarna AI Assistant Handles Two-Thirds of Customer Service Chats in Its First Month," Klarna, February 27, 2024.

- Oscilar's AI risk decisioning tool, which uses data from open and closed sources to identify potential fraud patterns and recommend solutions in real time.

- Norm Ai's regulatory AI agents, which assist with compliance assessments and help speed up regulatory functions through automation.

- Kobalt Labs' AI-powered risk copilot, which helps FIs conduct vendor and third-party due diligence by securely ingesting uploaded documents and flagging compliance breaches.

- Blee's AI-powered platform, which assists risk management teams in identifying compliance breaches from marketing materials.

Looking ahead, we expect high levels of AI-powered innovation to continue across all sectors in the financial industry. It is clear that leading players are preparing for a future where the use of AI technologies is highly prevalent; in August 2024, CIBC announced its plans to hire over 200 data and AI roles in the next year, and S&P Global partnered with Accenture to train all 35,000 of its employees on GenAI. However, while fintech companies are still rapidly innovating with AI, we believe winners in this space will not necessarily be those that launch AI products the quickest. Rather, it will be those that have access to robust datasets, strong knowledge of data science and how to create successful models, and the capabilities to comply with upcoming regulatory standards.

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Information security

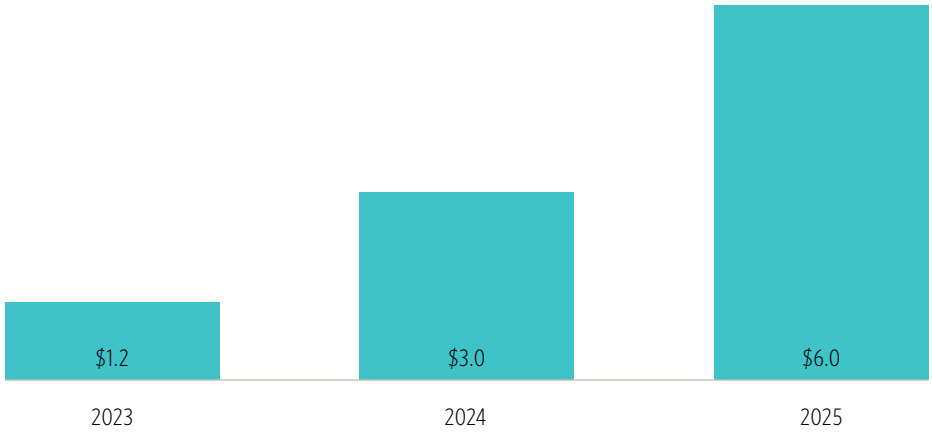
Prior expected impacts

GenAI is an area of tension for information security (infosec) given the risks of deploying LLMs and the limited applicability of the technology to practitioner workflows. Last year, we believed that GenAI could apply in limited use cases, including penetration testing, security documentation, secure coding, and better IT service chatbots. In practice, this prediction has come true with the launch of GenAI products in the space, yet these products serve limited roles within broader platforms. In the long term, we expected GenAI to change how security operations work is done, including a shift away from Security Information and Event Management (SIEM) platforms and the democratization of infosec analysis via visual incident response and generative security alerts. Despite widespread mistrust of AI systems in the infosec community, the pattern-matching workflows and patching exercises of infosec analysts are great fits for LLMs that can understand machine language.

Reality one year later

In 2024, incumbents have caught up to the LLM trend with a raft of GenAI product announcements incorporating the latest LLMs, some of which we covered in our RSA Conference recap. Infosec market leader Microsoft doubles as a GenAI market leader and has invested in its Security Copilot product that is growing like a startup within the conglomerate. According to IDC data, $3.0 billion will be spent on GenAI-augmented infosec software in 2024 across key use cases including application security, code security, fraud, and security operations, up 141.4% from 2023.[8] This figure should double in 2025.[9]

GenAI-augmented infosec spending estimate ($B)



Source: IDC • Geography: Global • As of August 20, 2024

8: "Worldwide AI and Generative AI Spending Guide," IDC, Karen Massey, et al., July 20, 2024.
9: Ibid.

Vendors are beginning to attribute revenue growth to AI products. In its Q4 fiscal year 2024 earnings call, Palo Alto Networks noted $200.0 million in annual recurring revenue from AI-integrated products, with a small part of that coming from LLM-native products, with new products planned in security for LLMs.[10] CrowdStrike launched an AI assistant called Charlotte yet does not tout the product's financial performance, instead referring to its next-gen security operations platform as AI native. SentinelOne claims its LLM product Purple AI contributed to financial outperformance and raised guidance in Q2 2024. Along with security operations chatbots, GenAI products have found their closest product market fit in tagging enterprise data for policy enforcement in novel data loss prevention products.

Real-world progress

Perhaps even more importantly for infosec vendors than incorporating AI on the back end of their products, emerging GenAI leaders are spending on cybersecurity. CrowdStrike closed its biggest inside sales deal ever, over eight figures, with a GenAI innovator for cloud security. 78% of the top 50 GenAI products run on Cloudflare, and the company has launched AI inference hosting and acceleration to welcome those customers.[11] This usage results in 67% quarter-over-quarter growth for its new Workers AI product. In its recent earnings call, the company also cited a $500,000 contract with a leading AI company for inference, storage, image optimization, and application security, showing the range of features that can be sold in this market.[12] While the industry figures out the unique vulnerabilities of LLM applications, hypergrowth companies will require conventional cloud security and secure web gateways, providing a tailwind that can make up for broad weakness in cybersecurity spending growth.

The long-term implication of the death of the SIEM industry that we predicted last year has moved faster than expected. Significant consolidation has occurred, as covered in our Q2 2024 Information Security Report, yet AI is not likely to completely displace existing platforms. Cloud-native security operations platforms like those of CrowdStrike and Palo Alto Networks are capturing market share from conventional SIEM platforms, showing that innovation can disrupt an existing market. From a new-product perspective, GenAI can augment existing SIEM platforms via simpler queries, data labeling, and contextual analysis. Startups have begun to form around LLM queries for a range of security tools beyond a conventional SIEM platform, obviating the need to centralize data in a single platform. We covered some of these startups we have met with in our RSA Conference recap. We believe that these companies can generate powerful data learning effects through LLMs' intelligence about diverse coding formats and can become security platforms of the future by layering in new data sources that even existing innovators cannot integrate.

10: "Q4 Fiscal Year 2024 Earnings Call," Palo Alto Networks, August 19, 2024.
11: "Investor Day 2024," Cloudflare, May 30, 2024.
12: "Cloudflare, Inc. (NET) Q2 2024 Earnings Call Transcript," Seeking Alpha, August 1, 2024.

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Insurtech

Prior expected impacts

A year ago, the anticipated impacts of GenAI in the insurtech sector were expected to be substantial, particularly in areas such as customer service, risk assessment, underwriting, and claims processing. The focus was on how AI could revolutionize the way insurers interact with customers, optimize policy structures, and speed up claims processing. Early experiments suggested that AI could enable highly personalized insurance products; more accurate risk assessments; and faster, more efficient claims resolutions. Notable examples included Zurich Insurance Group testing ChatGPT for data analysis and The Paladin Group collaborating with Dais Technology on UnderwriteGPT for underwriting automation.

We also expected that large insurance companies with vast datasets and resources to invest in AI would emerge as winners. These companies could leverage AI to streamline operations and offer more competitive and highly personalized products. Conversely, smaller companies, particularly those without the necessary infrastructure or data assets, were seen as potential losers, unless they could form strategic partnerships or utilize AI through third-party platforms.

Reality one year later

AI is indeed making headway in customer service and risk assessment within the insurtech sector. AI agents, initially limited to basic customer support, are now being enhanced with GenAI, allowing for more personalized interactions and more complex policy structures. Some of these AI agents interact directly with customers, while others support human insurance agents by helping them analyze customer data, providing real-time insights, and recommending optimal policy options. This dual approach not only enhances the efficiency of human agents but also ensures that customers receive tailored advice and faster service, ultimately improving overall satisfaction and operational effectiveness within the insurtech sector.

We have also seen quite a lot of adoption of AI for underwriting and claims processing. While both incumbent insurers and insurtech companies have leveraged AI for underwriting and claims processing in these areas for the past decade, we have seen an acceleration over the past year. In underwriting, AI is being increasingly used to analyze vast datasets to assess risk more accurately and efficiently than ever before. AI is now capable of evaluating a broader range of data points, including nontraditional data such as social media activity, satellite imagery, and climate data. Similarly, AI-driven tools are now capable of automating large portions of the claims process, from initial filing to final settlement. These tools can quickly assess the validity of claims, detect potential fraud, and even estimate repair costs using computer vision and predictive analytics. The result is a more efficient and customer-friendly claims experience, with faster resolutions and reduced administrative costs.

While AI-driven products are gaining traction, the regulatory and ethical concerns surrounding GenAI have created significant adoption hurdles. Insurers remain cautious, particularly in specialty and commercial lines, where the complexity of policies and claims still requires human intervention. On the other hand, new opportunities have emerged in developing insurance products for AI-native risks, such as IP infringement and data privacy, presenting an untapped market for insurtech innovators.

Real-world progress

YC-backed Fair Square Medicare, a Medicare enrollment platform, announced in August 2024 that it was using GenAI to develop AI-based voice agents that streamline Medicare enrollment for older adults, improving efficiency and customer experience. The AI voice agents screen potential customers for Medicare coverage, and the company claimed their performance matches that of human agents during business hours and significantly outperforms after hours. The technology is also being offered as an enterprise solution for large insurance distributors and carriers.

Earlier this year, automobile insurance startup Clearcover launched a GenAI solution to streamline the insurance claims process by digitizing statement collection immediately after the first notice of loss. This AI tool collects essential information to expedite claims processing and payment, enhancing the overall customer experience. The startup asserts that it can provide claims payments in as little as 30 minutes. Incumbent underwriting service Verisk also introduced a GenAI auto-summary feature in its Discovery Navigator platform, a medical-record-review tool for property and casualty claims professionals. The AI feature automates the extraction and organization of key medical data, enabling faster and more accurate claims settlements, potentially boosting efficiency and productivity for claims handlers.

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Consumer applications

E-commerce

Prior expected impacts

We previously highlighted three prominent use cases in e-commerce that could face material innovation via LLMs: The creation of individualized shopping assistants could support product discovery, lowered content creation costs could unlock "individualized" shopping, and back-office functions such as customer support could face greater automation. Key considerations included B2B adoption (a significant growth vector for digital commerce) and legal implications.

Reality one year later

This outlook generally materialized with incumbents racing to integrate AI features into their existing tool sets while startups targeted discrete points of friction in the shopping experience. While there is broad-spectrum adoption and long-term disruption potential, digital commerce does not quite present the same immediate paradigm shift evident in other industries such as interactive media. Further, specific functions, such as product search, have relatively entrenched behaviors that will take time to uproot.

Incumbents targeted conversational assistants (as seen with Amazon and Mastercard), product listing automation (Amazon, eBay, and Shopify), fraud migration (Mastercard), and select in-store interactions (Target). For startups and VCs, our note in 2023 demonstrated that customer support, conversational commerce, and AI-core services (the building blocks used to deploy AI models into production) gained the most traction.

Throughout the year, digital commerce vendors touted new AI functionalities, as seen with Salesforce's Einstein for its Commerce Cloud or Klarna's integration of GenAI to cut support and marketing costs. Elsewhere, select merchants and vendors struggled to articulate a clear, differentiated value proposition, underscoring that many vendors are still ironing out their narratives. C-suite leaders face pressure to invest in AI, which squeezes adjacent line items, many of which touch the e-commerce stack.

Real-world progress

Disruption in search and discovery is percolating. Walmart recently released intent-based queries (such as "I need a Valentine's Day gift") rather than keyword-based searches (such as "flowers" or "chocolate") on its digital properties. Startup activity in this category is also strong: Perplexity is a meaningfully competitive alternative to Google. Further, startups such as Profound aim to improve brand visibility within responses from ChatGPT or Gemini, akin to search engine optimization practices.

Conversational AI remains highly relevant in e-commerce as well. Consumers face more choices than ever, and intelligent assistants can alleviate this cognitive load. Remark brings expert opinions into a concierge service for high-complexity items; Duckbill leverages "human-in-the-loop" automation for daily tasks, such as scheduling a home pickup to return an online purchase; and Daydream uses shopper intent to return relevant products.

PitchBook users can view the full list of GenAI e-commerce startups here.

Code completion is lowering the barrier to entry and implementation costs for headless, composable, and API-first services. Development teams face material complexity in traversing archaic, disparate internal systems, which services such as GitHub's Copilot can meaningfully reduce.

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Gaming

Prior expectations

We previously anticipated a broad-spectrum impact of LLMs on the gaming industry—spanning user-generated content (UGC), code completion, asset generation, and efficiency gains—from small startup studios that could simply move faster than incumbents. These applications primarily impacted back-end game design rather than front-end user experiences and game mechanics. We also highlighted risks from job displacement, amplified challenges with toxicity and content quality, and hype-cycle exuberance akin to Web3.

Reality one year later

One year later, these predictions have generally come to fruition. AI-native tools have produced material efficiency gains as content output velocity accelerates, gameplay deepens, and the barrier to content creation is lowered. Gaming has also been a proving ground for public demonstrations of AI capability via LLM-coded games of Snake, computational agents trained in simulation gaming, and real-time neural network generation. Incumbent adoption was unsurprisingly prominent given ballooning development budgets, public market expectations, and long-standing industry expertise. Roblox's Code Assist launched as a code completion service for content creators while it pushed toward 4D GenAI. Ubisoft debuted its NEO NPC at the 2024 Game Developers Conference (GDC). King is using GenAI to accelerate level design in Candy Crush. In EA Sports FC 24, the number of in-game animations improved by 10x while asset creation timelines fell by a factor of 10.[13] Although enterprise adoption led the way, legal, regulatory, and copyright risks pose material headwinds for many of these services.

The industry has grappled with widespread job losses since our last note, but this is more attributable to a weaker content release schedule and a maturing console cycle than structural job displacement. This will likely take years to unfold as localization, support, playtesting, and low-level design work are increasingly automated. Further, UGC platforms did not face a deluge of low-quality content. The barrier to content creation remains sufficiently high, though curation and discoverability are present challenges.

Real-world progress

Industry adoption of low-hanging fruit use cases continue to be widespread. According to Unity's annual state of game development report, current use cases can be broadly categorized into producing content/assets more efficiently, expediting iteration and time to market, and experimenting with novel in-game experiences.[14] Common applications include character animation; code completion; level, art, and narration design; and playtesting. Additionally, over 70% of developers report that AI improves their content delivery and operation.[15]

13: "EA CEO Thinks Generative AI Use Can Make Players Spend up to 20% More Money on Games," Sports Illustrated, Marco Wutz, March 7, 2024.
14: "2024 Unity Gaming Report," Unity, March 18, 2024.
15: Ibid.

The emergence of novel in-game mechanics, previously impossible without GenAI, are also percolating. For example, in the title Bloodsuckers, a human-controlled vampire must convince AI-powered NPCs to enter their homes in order to suck their blood. The capabilities and responsiveness of these characters go well beyond previous instances of rigid rules-based behavior. GenAI NPCs can also be deployed for QA and playtesting with much greater cost efficiency than simply hiring more people to "bug bash."

In January, sessions demonstrating real-time level design attracted large audiences at the GDC. By September, Google released GameNGen, which used an image-generation model to predict the next frame of the game without any of the underlying assets or code. In this time, generation speeds improved markedly. Small, AI-native or technology-first studios such as Lil Snack, Volley, and Embark Studios, which are reportedly able to develop content at a "torrid" pace,[16] are beginning to emerge, and we maintain our expectation of another wave of small teams developing world-class content.

Code completion services will also continue to support switching and porting efforts. Porting titles is a painful endeavor (though a valuable one, as Nintendo's acquisition of Shiver Entertainment demonstrated) because platform specs have many esoteric nuances. Similarly, switching from one engine to another is typically cost-prohibitive, but the recent Unity debacle underscored the implications of platform lock-ins.

Select VC-backed gaming companies

Company	Last financing date	Total raised ($M)	Last known valuation ($M)	Last known valuation step-up	Predicted exit type	Exit Opportunity Score
ElevenLabs	June 18, 2024	$103.0	$1,000.0	9.2x	M&A	78
Inworld	N/A	$119.8	$515.0	1.9x	IPO	99
Luma AI	January 9, 2024	$66.6	$220.0	1.8x	M&A	86
Modulate	November 1, 2023	$36.0	$170.0	7.0x	No exit	52
Omni Creator Products	June 6, 2022	$20.6	$76.3	3.9x	M&A	85
Polycam	February 7, 2024	$22.2	$70.0	1.6x	M&A	95
Spline	August 13, 2024	$32.4	$45.0	0.6x	M&A	98
GGWP	July 19, 2023	$33.3	$40.0	3.4x	M&A	69
Voicemod	September 1, 2024	$22.5	$27.0	N/A	M&A	97
rct AI	February 1, 2023	$22.1	$22.7	2.8x	N/A	N/A

Source: PitchBook • Geography: Global • As of September 18, 2024
Note: Probability data is based on PitchBook VC Exit Predictor methodology.

16: "Earnings Letter: Q4 and Full-Year 2023," Nexon, February 8, 2024.

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Industrial applications

Agtech

Prior expected impacts

A year ago, we anticipated that AI would significantly transform agriculture through applications such as crop disease diagnosis, yield prediction, precision agriculture, and livestock monitoring. We envisioned GenAI being used to analyze crop images for early disease detection, AI-driven models to forecast yields using historical and real-time data, precision systems to optimize resource use, and sensors to enhance livestock health monitoring. As AI became cheaper and more powerful, we anticipated that tech-savvy farmers and early adopters would benefit the most, using AI to adapt to climate change, improve yields, and conserve resources, while practitioners of traditional farming methods might struggle to keep pace with these advancements.

Reality one year later

The expected effects of AI on agriculture are beginning to take shape, though the level of success varies considerably among different use cases. In crop disease diagnosis, AI has achieved remarkable accuracy, with convolutional neural networks demonstrating testing accuracies of 97% to 99% in categorizing diseases across various crops, such as apples, corn, and tomatoes.[17] Yield prediction models have been enhanced by AI, leveraging historical and real-time data, though they still face challenges in accounting for extreme weather events.

Precision agriculture has seen significant advancements, with industry leaders such as AGRIVI and John Deere implementing AI-driven systems that optimize resource use through real-time monitoring and predictive analysis. These systems integrate AI, satellite imagery, and IoT technologies to enhance efficiency and productivity in farming operations.

In the realm of livestock monitoring, AI-powered sensors have markedly improved animal health tracking and management. Companies such as Plainsight offer vision AI platforms for accurate livestock monitoring, while SAS, in collaboration with Microsoft Azure, provides comprehensive AI and IoT solutions that optimize growth cycles and enhance animal welfare.

While development is progressing as anticipated in areas such as precision agriculture, other domains are advancing more slowly due to persistent challenges. These include issues with data quality and model generalization and the need for adaptive systems capable of handling unforeseen environmental events. The availability of high-quality localized data remains a significant adoption hurdle, as does the reliability of sensors in varied agricultural environments.[18]

17: "Early Detection of Crop Diseases Using CNN Classification," National High School Journal of Science, Aryan Rajvanshi, February 23, 2024.
18: "Artificial Intelligence and Sensor Technologies in Dairy Livestock Export: Charting a Digital Transformation," National Library of Medicine, Sensors, Suresh Neethirajan, August 9, 2023.

Despite these challenges, new opportunities have emerged. There is growing potential in integrating more comprehensive datasets to improve the resilience of AI systems in agriculture. Additionally, there is a push toward developing AI models that can adapt to local conditions and crop varieties, promising more tailored and effective solutions for farmers across diverse geographies and climates.

Real-world progress

Several startups and established companies are making notable progress with AI-powered products in the agricultural technology (agtech) space. Oishii, which recently secured a $144.0 million Series B funding round, is leveraging AI and vertical farming technology to produce premium strawberries. Inari, backed by $627.0 million in VC funding to date, is using AI and gene editing to develop more resilient and productive seeds. Monarch Tractor, which recently secured a landmark $133.0 million Series C funding round, is developing AI-powered autonomous tractors. According to Monarch, its MK-V model, the world's first fully electric, driver-optional smart tractor, has already helped offset more than 850 tons of carbon dioxide emissions across 42,000 hours of tractor operations.[19]

Promising product sets include AI-driven sensors and drones for soil health and crop condition monitoring, such as those developed by Aigen. This Seattle-based startup, founded by former Tesla engineers, has created a solar-powered robot that autonomously removes weeds and gathers data for farmers. Carbon Robotics, another Seattle startup, offers weed-zapping robots for sustainable farming practices. The company raised $56.0 million in July.

TerraClear, which uses ML and hardware to remove rocks from fields, exemplifies the development of AI-powered autonomous machinery for specific agricultural tasks. Meanwhile, companies such as AgriPredict are creating AI-powered mobile apps for real-time crop disease identification, addressing crucial pain points for farmers.

These startups are finding success by focusing on specific, high-impact areas of agriculture; integrating multiple technologies for comprehensive solutions; and addressing real pain points for farmers. To further succeed, these startups may need to improve data quality and availability, develop more adaptive AI systems, and ensure their solutions are accessible and affordable for a wide range of farmers, including small-scale operations in developing countries. For instance, Pollen Systems, founded by a former Microsoft executive, is working on improving its deep learning and visual AI models by collecting more acres of data and imagery to enhance its GenAI solutions for high-value crops.

19: "Monarch Tractor Announces $133M Series C Funding," Monarch Tractor, July 22, 2024.

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Climate tech

Prior expected impacts

While there are several areas for potential GenAI applications within climate tech, much of the discourse over the past year has focused on mitigating the impacts of GenAI's high energy consumption—and the associated carbon footprint. GenAI model training and querying is a very energy-intensive process, involving substantial processing power and data inputs. As we discussed a year ago, wide adoption of GenAI will result in a rapid increase in datacenter carbon emissions. Datacenters already account for 1% to 2% of global power consumption, and this is anticipated to grow to 3% to 4% by 2030.[20]

Reality one year later

Rising datacenter emissions are putting pressure on emissions reduction targets, but new approaches to mitigate these emissions are being developed. Direct energy consumption can be reduced through more powerful, energy-efficient computational hardware, which can allow improved performance while simultaneously reducing energy consumption.[21] Code optimization can similarly reduce overall emissions, particularly for the initial model training steps.[22] Outside of these methods, there are three main ways to reduce datacenter emissions:

- **Energy efficiency improvements:** Datacenter energy consumption has two components: energy used by computational components, and energy used by operational components, such as cooling and lighting. By improving the efficiency of operational components, the overall "power-use efficiency" of the datacenter can be improved. This can involve higher-efficiency cooling technologies or methods to obtain value from the heat generated by datacenters.

- **Low-carbon energy:** Carbon emissions from electricity use can be mitigated through increased adoption of low-carbon energy sources, potentially including dedicated renewable energy installations alongside datacenters. Adding large-scale energy storage can also facilitate broader use of these low-carbon energy resources.

- **Datacenter location:** Because a large component of datacenter emissions is cooling related, placing datacenters in cooler locations can reduce the overall need for cooling. Similarly, increasing the scale of datacenters can improve energy efficiency, and co-located datacenters are one way to achieve this by allowing users to rent space in a much larger datacenter with shared operational components.

20: "AI Is Poised to Drive 160% Increase in Data Center Power Demand," Goldman Sachs, May 14, 2024.
21: "Nvidia's Blackwell AI 'Superchip' Is the Most Powerful Yet," NewScientist, Jeremy Hsu, March 19, 2024.
22: "New Tools Are Available to Help Reduce the Energy That AI Models Devour," MIT News, Kylie Foy, October 5, 2023.

Real-world progress

VC-backed companies are supporting datacenter decarbonization through several methods. Solar installation companies that cover commercial and industrial applications typically include datacenter installations in this category, either for roof-mounted solar panels or simply installation nearby. Similarly, startups developing energy efficiency cooling systems for buildings sometimes target the datacenter segment as a consumer of energy-efficient cooling systems.

Other VC-backed companies are focusing specifically on datacenter applications:

- **Crusoe** is the largest of these by total capital raised and focuses on developing datacenters located close to clean energy from renewables or to stranded energy, such as natural gas that otherwise would be flared (natural gas that is burned off rather than collected due to limited infrastructure to leverage it economically). The company initially focused on using natural gas that otherwise would be flared for cryptocurrency mining because, as a waste product, stranded gas is very cheap. With AI applications driving growth in datacenter energy usage, Crusoe now focuses on both crypto and datacenter applications. Earlier this year, datacenter revenues outpaced the company's crypto-driven revenues for the first time.[23]

- **Nautilus Data Technologies** develops high-efficiency datacenter infrastructure, supporting both air and liquid cooling. In addition to improved energy efficiency, the company also focuses on maximizing water use efficiency at its datacenters, which can utilize fresh water, gray water, or salt water.[24] The company raised $104.5 million in Series A funding in Q3 2024.

- **Submer** develops immersion cooling technology for datacenters, in which computational components are immersed in proprietary cooling fluids to allow rapid heat exchange. The company develops multiple sizes of modular immersion vessels, plus the immersion fluids themselves. Immersion cooling can provide high-efficiency cooling, increasing the power-use efficiency of a datacenter, thereby reducing energy costs and the environmental footprint. It can also reduce water use and provide opportunities for utilizing heat extracted from datacenter operations.

23: "How a Natural Gas-Powered Bitcoin Miner Became a Darling of Climate Tech," Crusoe, Katie Brigham, May 29, 2024.
24: "Sustainable by Design," Nautilus Data Technologies, n.d., accessed September 17, 2024.

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Defense tech

Prior expected impacts

Upon its mainstream arrival last year, GenAI was expected to have limited immediate impacts on the defense tech sector, primarily due to potential security issues and the need for bespoke data training. Still, it was anticipated that LLMs would eventually play a significant role in supporting real-time decision-making processes by synthesizing disparate data sources.

It was also thought that GenAI would revolutionize autonomous systems in defense, particularly in the deployment of unmanned ground vehicles and drones. Such systems would enhance surveillance, reconnaissance, and targeted strikes. Another expected use case included predictive maintenance systems that could reduce equipment downtime and improve operational readiness.

The proliferation of AI systems was predicted to benefit large defense contractors and technology companies that were early adopters. These entities, with their significant capital investments, were positioned to leverage AI effectively. Conversely, traditional defense companies and smaller subcontractors that failed to integrate AI into their products or processes were expected to lag technologically. Startups, particularly those focused on software-forward products tailored for defense applications, were seen as potential winners.

Reality one year later

While the sector is still in its early stages of AI integration, development in AI defense appears to be progressing as anticipated, with clear demand from the government. AI is being employed in various applications, including simulations, autonomous drones, predictive maintenance, and offensive cybersecurity. Companies such as Palantir and Anduril Industries are utilizing AI for sensor fusion and predictive analytics on the battlefield. Startups such as Shield AI are deploying autonomous drones, while others, such as Saronic Technologies, are expected to field unmanned surface vehicles for maritime operations.

While AI is being used for decision support and predictive maintenance, the integration of AI into fully autonomous systems is proceeding more cautiously due to ethical concerns and technical feasibility challenges.

However, there have been some unexpected developments. Cost overruns associated with AI systems and the required computing power have been significant. Additionally, ethical concerns and uncertainty about how data is synthesized and analyzed have led some agencies, such as the US Space Force, to occasionally pause their adoption of GenAI. These factors have caused some program officers to adopt a more cautious approach to AI integration.

Real-world progress

Despite these challenges, companies such as Shield AI, Palantir, and Anduril have secured major contracts, and their products are actively being deployed on the battlefield. Notably, Anduril was recently selected for the US Air Force's Collaborative Combat Aircraft program, which aims to build autonomous drones that can collaborate with fighter jets. The Air Force plans to invest nearly $9 billion in this program through fiscal year 2029.

Decision support and autonomy are emerging as the most promising use cases for AI in defense. Cross-domain technology, which enables software to synthesize and act on data from various disparate sources, is becoming increasingly critical for operational needs.

The success of startups in this space is largely due to their focus on niche AI applications that directly address critical defense needs, such as autonomy in high-risk environments and advanced data analytics for intelligence. Their success will likely be further bolstered by continued government contracts and partnerships with established defense contractors.

Recent AI defense tech VC and PE deals

Company	Description	Deal value ($M)	Deal date (2024)	Deal type
Anduril Industries	Defense technology company intended to solve critical challenges in the national security sector. The company leverages virtual and augmented reality algorithms, computer vision, sensor fusion, optics, and automation to monitor threats and improve surveillance, enabling clients to transform defense capabilities and solve complex national security challenges.	$1,500.0	August 7	Late-stage VC
Applied Intuition	Developer of advanced simulation infrastructure software designed to safely develop, test, and deploy autonomous vehicles. The company's software offers a suite of products that focuses on simulation and analytics and delivers sophisticated infrastructure built for scale, enabling automotive industries to comprehensively test and rapidly accelerate their autonomous vehicle development.	$300.0	July 25	Secondary transaction - private
Saronic Technologies	Manufacturer of unmanned surface vehicles intended to enhance maritime security and domain awareness. The company designs and builds naval hardware, software, and related AI technologies into one scalable, fully integrated platform, enabling the defense and surveillance sectors to achieve comprehensive operational capabilities.	$175.0	July 19	Early-stage VC
Skydio	Developer of AI-powered drones that use an array of cameras and proprietary computer vision technology to recognize and avoid objects in real time and predict the future to make intelligent decisions, enabling users to fly through various tasks and be safe from obstacles when they want to take control.	$64.0	May 13	Late-stage VC

Source: PitchBook • Geography: Global • As of August 29, 2024

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Foodtech

Prior expected impacts

Last year, we predicted several potential applications of AI in the food industry, including interactive cooking apps, smart shopping lists, menu optimization, and personalized meal planning. We expected AI to be adopted in ways that would enhance consumer experiences and streamline operations in the food service sector. This included the integration of AI chatbots for customer service, AI-driven inventory management systems, and predictive analytics for demand forecasting in restaurants and food retail.

As AI became more affordable and powerful, we foresaw that tech-savvy consumers comfortable with digital platforms would benefit from more personalized and efficient food experiences. Larger, innovative food businesses, particularly those in the quick-service restaurant and food delivery sectors, were expected to gain competitive advantages through AI-driven operational efficiencies and customer insights. However, we also recognized that traditional food service models might face challenges in adapting to these new technologies. Small, independent restaurants and food businesses with limited technological infrastructure or expertise were anticipated to struggle with the initial investment and learning curve associated with AI implementation. Additionally, we foresaw potential resistance from consumers concerned about data privacy and the loss of human touch in food experiences, particularly in fine dining establishments.

Reality one year later

AI-driven cooking apps and smart shopping lists have gained traction, offering personalized recipe suggestions and efficient grocery planning. For instance, Innit uses AI to provide personalized meal recommendations and cooking guidance based on dietary preferences and available ingredients. Similarly, Samsung Food leverages AI to create smart shopping lists and meal planning tools that integrate with various grocery retailers and smart kitchen appliances. Cherrypick, a UK-based startup, has developed an AI-powered meal planning and grocery shopping platform aimed at reducing food waste and simplifying meal preparation.

Some restaurants have adopted menu optimization through AI to enhance customer satisfaction and operational efficiency. Companies such as Tastewise, which has raised $29.5 million in VC funding, use AI to analyze food trends and consumer preferences, helping restaurants optimize their menus. Another player, Deliverect provides AI-driven menu management and order aggregation for restaurants. These platforms cater to individual dietary needs and preferences, streamlining the dining experience for both restaurants and customers.

Leaders in AI adoption for foodtech include companies such as NotCo, which is developing an AI-driven plant-based food development platform. Perfect Day, which has raised $801.5 million in VC funding, is using AI and precision fermentation technology to develop animal-free dairy proteins. Spoonshot, recently acquired by Target Research Group, uses AI for food trend prediction and product innovation.

While personalized recommendations and menu optimization are progressing well, more complex systems such as fully automated kitchens are advancing more slowly. Miso Robotics has developed AI-powered kitchen assistants, but widespread adoption remains limited. Similarly, AI-driven food safety monitoring systems are still in early stages, with companies such as ImpactVision (acquired by Apeel Sciences) working on hyperspectral imaging and AI for food quality assessment.

Unexpected developments include the persistence of data privacy concerns and the challenge of integrating AI systems into existing food service infrastructure. New adoption headwinds have emerged, including the need for more robust data security measures and the challenge of ensuring AI recommendations align with food safety regulations.

New opportunities have arisen in areas such as AI-driven food waste reduction systems and advanced nutritional analysis tools. Wasteless uses AI to optimize pricing for perishable products, reducing food waste in supermarkets. Nutrino (acquired by Medtronic) has developed an AI-powered platform for personalized nutrition recommendations. These innovations promise to address critical issues in the food industry while providing new avenues for business growth.

Real-world progress

Several startups are making significant progress with AI-powered products in foodtech. For instance, NotCo has developed an AI platform called Giuseppe that analyzes plant-based ingredients to create animal product alternatives, addressing the growing demand for sustainable and plant-based foods. The company has raised $431.8 million in VC funding and has successfully launched products in multiple countries.

Promising product sets include AI-driven food waste reduction systems, advanced nutritional analysis tools, and personalized meal recommendation platforms. These technologies are showing potential in improving sustainability, enhancing consumer health, and personalizing food experiences, respectively.

Winnow Solutions, a London-based startup, has developed an AI-powered computer vision system that helps commercial kitchens cut food waste. The company claims its technology can help kitchens reduce food waste costs by up to 12%.[25] Winnow has raised $44.8 million in VC funding and works with major hospitality brands worldwide.

Byte Kitchen, which has raised $6.0 million in VC funding, is using AI to add automation to multibrand ghost kitchens, addressing the growing demand for efficient food delivery operations. The company's technology optimizes kitchen processes and order fulfillment across multiple virtual restaurant brands.

These startups are finding success by focusing on specific, high-impact areas of the food industry, integrating multiple technologies for comprehensive solutions, and addressing real pain points for both consumers and businesses. To further succeed, these startups may need to improve data quality and availability, develop more adaptive AI systems, and ensure that their solutions are accessible and affordable for a wide range of businesses, from small local restaurants to large food service chains.

25: "The Business Case for Using Food Waste Technology," Winnow Solutions, n.d., accessed September 19, 2024.

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Mobility tech

Prior expected impacts

In early 2023, it appeared that some of the near-term impacts of GenAI in mobility tech would be in infotainment systems, where a conversational interface would emerge to integrate with cabin controls, navigation systems, entertainment, and communications. In automotive software development, an area where traditional original equipment manufacturers (OEMs) have struggled, coding automation and completion could boost productivity. In transit routing and scheduling, passengers and trip planners could have a more conversational interface. Ride-hailing apps could enhance the booking and user experience. In the long term, automotive design and development efforts could benefit from tools to rapidly generate myriad prototypes, enhancing creative productivity. As automakers transition to electric vehicle (EV) production lines, manufacturing optimization could get a boost from GenAI tools.

Infotainment and enhanced software development appeared to be the key areas where GenAI would make a difference in the near term. Despite the widespread adoption of smartphone-like interfaces on car infotainment systems, navigating them remains confusing and distracting for many drivers. Existing voice command systems often struggle to correctly interpret cues, and drivers often abandon them after a few tries. The more conversational interface offered by GenAI systems seemed like a clear remedy to the distraction and challenges of existing systems. Another near-term opportunity, GenAI code assistants could provide dramatic productivity improvements for developers. Given the struggles traditional OEMs have had with software development projects, this seemed like a natural and ready application of the technology.

With their investments in GenAI and control of compute infrastructure, Google and Microsoft have a strong lead in adding GenAI to infotainment and vehicle control systems. Apple, with the strength and ubiquity of its CarPlay platform, is also in a strong position to add GenAI conversational control capabilities. Auto OEMs as well as Tier 1 suppliers such as Bosch and Valeo, which already have an established presence in vehicle control systems and software, stand to benefit as GenAI software development tools and processes grow. Valeo has recently partnered with Google to utilize its Google Cloud GenAI solutions to spur productivity across its software engineering processes.

Reality one year later

Microsoft and TomTom have partnered in a conversational GenAI control system for navigation and infotainment, as detailed in our Q1 2024 Mobility Tech Report. The system as demonstrated acts more like a helpful travel companion providing useful information with minimal driver distraction. Mercedes Benz beta-tested a conversational GenAI system in the second half of 2023 and provided more details of the MBUX Virtual Assistant at CES 2024. Volkswagen also announced plans to partner with Cerence to integrate ChatGPT into its IDA voice assistant system.

Western auto OEMs are still struggling with software development, and GenAI projects are slowly emerging. At its Worldwide Developers Conference, Apple rolled out next-generation CarPlay features, which include deeper integration into vehicle control systems. The launch of new iPhones and iOS software could add further functionality. Chinese EV makers have aggressively adopted GenAI from technology providers such as Baidu, with its ERNIE Bot, and Huawei. FAW Group is incorporating Alibaba Cloud's LLM Qwen into its development and business decision processes. Alibaba Cloud already provides cloud computing services to more than 70% of domestic automakers in China.[26]

Real-world progress

In a somewhat unusual turn, GenAI and related AI technology has recently driven a rebound in VC investment in autonomous driving technology. In Q2 2024, the value of VC deals in autonomous driving rose more than 80% QoQ with sizable deals in Waabi and Scale AI. As detailed in our Q2 2024 Supply Chain Tech Report, Waabi is using GenAI-created synthetic environments to train autonomous driving systems. Compared with massive real-world video-capture training schemes such as those deployed by Tesla, Waabi's training tools can rapidly generate a variety of scenarios cost-effectively as well as training nuances for dangerous or difficult edge cases that would be unlikely or unethical to effectively capture from real-world training.

Select AI mobility tech startups

Company	Last financing date	Company financing status	Last financing deal type	Last financing value ($M)	Last financing valuation ($M)
Waymo	July 23, 2024	VC backed	Late-stage VC	$5,000.0	N/A
Nuro	February 21, 2024	VC backed	Accelerator/incubator	N/A	N/A
Horizon Robotics	April 1, 2024	VC backed	IPO	N/A	N/A
Scale AI	May 21, 2024	VC backed	Late-stage VC	$1,000.0	$14,000.0
WeRide	June 14, 2024	VC backed	Late-stage VC	$20.0	N/A
Wayve	August 29, 2024	VC backed	Late-stage VC	$1,050.0	N/A
Beijing Momenta Technology Company	May 5, 2024	VC backed	IPO	$250.0	N/A
DiDi Autonomous Driving	October 13, 2023	VC backed	Early-stage VC	$149.0	N/A
Pony.ai	October 24, 2023	VC backed	Late-stage VC	$100.0	$8,500.0
Cerebras	April 2, 2024	VC backed	IPO	N/A	N/A
Waabi	June 16, 2024	VC backed	Early-stage VC	$200.0	N/A
Gatik	August 21, 2024	VC backed	Late-stage VC	N/A	N/A

Source: PitchBook • Geography: Global • As of August 30, 2024

26: "Chinese Automaker FAW Group Taps Alibaba Cloud's Gen AI for Business Intelligence," Alibaba Cloud, March 25, 2024.

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Space tech

Prior expected impacts

A year ago, the emergence of GenAI presented both promising opportunities and significant challenges for the space tech sector. Initial expectations focused on AI's potential in satellite data analysis, mission planning, and design. While there was hope for AI's integration into autonomous spacecraft operations, the harsh space environment, particularly the damaging effects of radiation on electronics, suggested that such advancements would be a longer-term goal.

Reality one year later

Some of the anticipated impacts of AI in space tech are beginning to materialize, albeit gradually. Companies are still refining AI tools to meet specific operational needs, and widespread AI integration remains in its early stages. However, several companies have already emerged as leaders in applying AI to operations and product development.

For example, Relativity Space uses AI in its autonomous rocket manufacturing processes, while Slingshot Aerospace has developed AI-enabled software for spacecraft simulations, attracting the attention of NASA and the Space Force. The acquisition of Exo-Space by Sidus Space in August 2023 marked another significant development. Exo-Space's expertise in space-based edge processing and AI has been integrated into Sidus Space's FeatherEdge system, which plays a critical role in satellite data analysis for mission control and design. True Anomaly, another startup, has introduced the Mosaic mission control platform and is developing an autonomous orbital vehicle called Jackal.

Real-world progress

Despite these advancements, the pace of AI development in space tech has been slower than anticipated, largely due to high capital requirements and the unique demands of space operations. Nevertheless, a notable and unexpected development has been the rapid improvement in AI's ability to process and analyze vast amounts of data from Earth observation.

Several challenges persist, particularly the extreme conditions of space and the need for highly reliable systems, which have slowed AI's integration into critical mission operations. These technical hurdles have emerged as significant barriers to adoption.

Certain companies are making notable strides despite these challenges. Planet Labs, for instance, is effectively using AI to manage large datasets from Earth observation satellites. AI-powered Earth observation platforms that offer real-time data analytics are among the most promising products in the sector.

The success of startups in this space is largely due to their focused application of AI to address specific, critical problems in space operations, such as autonomous navigation and real-time data processing. Moving forward, their success could be further enhanced through stronger collaborations with space agencies and continued investment in AI research tailored to the demanding environment of space.

As AI technology becomes more accessible and powerful, companies that effectively leverage AI for satellite data analysis are poised to benefit the most. This capability is key to improving Earth observation, mission planning, and space situational awareness. Additionally, AI-driven autonomous manufacturing and predictive maintenance tools are expected to provide a competitive edge in spacecraft production.

Recent AI space tech VC deals

Company	Description	Last financing value ($M)	Last financing date (2024)	Last financing deal type
Synspective	Developer of a technology designed to utilize and integrate data from satellite constellations, Big Data, and ML. The company's technology provides various satellite services, such as remote sensing and satellite imagery using small-sized synthetic aperture radar satellites that can measure human activity over a wide area, regardless of time or weather, enabling clients to achieve their sustainable development and resilient urban development goals.	$44.6	June 20	Late-stage VC
Picogrid	Developer of a field intelligence technology platform designed to provide continuous and real-time insight into remote locations. The company's platform provides terminals with sensors and cameras that can be deployed anywhere with unlimited satellite broadband and can be connected to a wide range of existing sensors, cameras, and SCADA equipment to provide deeper visibility and real-time alerts, enabling enterprises and government organizations to digitize and monitor the remote world.	$12.0	March 26	Seed
AiDash	Developer of an AI-based sustainable platform intended to facilitate satellite-powered operations and maintenance in core industries. The company's platform offers services including utility vegetation management, remote monitoring, and inspection of hazards along power lines, enabling clients to manage their work efficiently and make informed decisions.	$58.5	January 10	Late-stage VC

Source: PitchBook • Geography: Global • As of August 29, 2024

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Supply chain tech

Prior expected impacts

In early 2023, we surmised that ChatGPT could be used to improve queries and order tracking in supply chain management. Third-party logistics and freight forwarders could see productivity benefits from optimized scheduling, planning, and pricing. A key constraint or concern was data and API accessibility. Much of the data in supply chains is proprietary and closed. Open data access is critical in order to benefit from optimization, prediction, and automation.

Reality one year later

Areas where GenAI tools and applications are now under development and being deployed include inventory management, where predictive insights from historical data on stock requirements can be used to optimize inventory and cost. Demand forecasting is another key area of development using data from consumer behavior patterns and trends in the market. Customer service and relationship management, including automating the processing of inquiries and troubleshooting, are other functions under development.

Other applications that are rolling out include queries of warehouse management systems. In a recent webinar, Manhattan Associates said it sees managers asking queries such as "Who are the most productive pickers?" and "What are optimal assignments in the warehouse?"[27] More process-oriented tasks include configuring and optimizing a warehouse management system. Walmart has adopted chatbots to negotiate simple contracts with suppliers. Vendors such as Zycus are piloting the use of ChatGPT in procurement, including in supplier selection, contract management, and supplier performance tracking. Supply chain managers are using GenAI tools to create sustainability reports from ESG and supplier data. GenAI has opened up a whole new realm of possibilities for improving supply chains, but data access and change-management challenges persist.

Real-world progress

A recent EY report surveyed the use of GenAI in supply chains and the development of autonomous supply chains, where supply chains dynamically adjust with limited intervention. According to the report, 73% of supply chain executives are planning to deploy GenAI, but only 7% have completed implementation.[28] Managers still struggle with the complexity of systemic implementation and some of the unique risks posed by GenAI.

Supply chain risk management is one area where AI tools are gaining traction. In our Q2 2024 Supply Chain Tech Report, we highlighted Prewave, which has developed a platform to monitor suppliers across social media and provide risk alerts across more than 50 specific categories. The Austrian company completed a $68.0 million Series B round in June.

27: "Harnessing the Power of Gen AI in the Supply Chain," Manhattan Associates, Brian Kinsella, et al., June 26, 2024.
28: "How Will GenAI Prompt a Step Change Toward Autonomous Supply Chains?" EY, Glenn Steinberg, et al., June 6, 2024.

Select AI supply chain tech companies

Company	Last financing date	Last financing value ($M)	Last financing deal type
Prewave	June 25, 2024	$68.0	Late-stage VC
Silo	November 15, 2023	$35.0	Late-stage VC
Gideon	April 15, 2024	$31.0	Late-stage VC
Orca AI	May 23, 2024	$23.0	Late-stage VC
Traydstream	September 26, 2023	$21.0	Late-stage VC
Syrup Tech	January 23, 2024	$17.8	Early-stage VC
Gather AI	February 9, 2024	$17.0	Late-stage VC
Accrete	April 4, 2024	$15.0	Late-stage VC
UHAlean	December 4, 2023	$13.9	Late-stage VC
Pensa	January 11, 2024	$13.5	Late-stage VC
Clarium	August 20, 2024	$12.5	Seed
Parspec	February 27, 2024	$11.5	Seed
Hurricane	April 3, 2024	$11.4	Late-stage VC
Noodle.ai	January 11, 2024	$10.0	Late-stage VC

Source: PitchBook • Geography: Global • As of August 30, 2024

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Healthcare applications

Biotech

Prior expected impacts

A year ago, the anticipated impacts of generative AI in the biopharma sector were expected to be transformative, particularly in areas such as drug discovery, clinical trial design, personalized medicine, and operational efficiencies. The focus was on how AI could accelerate the drug development process, improve the accuracy of predictive models for patient outcomes, and optimize supply chain and manufacturing processes. Valo Health and insitro led the way with mega-rounds in the early efforts. Many billion-dollar drug development partnerships were secured, including between Bayer and Recursion Pharmaceuticals for oncology and Gilead Sciences and insitro for nonalcoholic steatohepatitis (NASH).

Specifically, AI was expected to start being adopted by biopharma companies, primarily in R&D, with ML models being used to identify potential drug candidates and optimize clinical trial designs. Additionally, AI-driven tools were anticipated to enhance patient stratification in clinical trials, thus improving trial success rates. As AI became cheaper and more powerful, large pharmaceutical companies with significant data resources and the ability to invest in AI technology were expected to be the winners. In contrast, smaller companies without the necessary infrastructure or data assets were seen as potential losers if they could not form strategic pharma partnerships or work with clients as contract research organizations.

Reality one year later

AI is making strides in drug discovery and development, particularly in identifying novel drug candidates and optimizing formulations. However, adoption has been slower in other areas, such as clinical trials, due to regulatory concerns and integration challenges. There has not been any meaningful M&A activity in the space for Big Pharma, signaling that the value of AI platforms is potentially only in the drug assets with strong clinical data. The all-stock acquisition of Exscientia by Recursion was viewed more as a consolidation to combine resources to survive. This might drive companies such as Insilico Medicine and Recursion, which were previously viewed as front-runners, to think in the long term, leveraging AI to accelerate drug development. On the Big Pharma end, these companies will potentially opt to build the AI platforms in-house as the space matures and talent becomes easier to hire. Unexpectedly, despite the slow progress of AI drug candidates, we have seen an uptick in GenAI-related megadeals in VC, including for Formation Bio, Generate Biomedicines, EvolutionaryScale, and Xaira Therapeutics. On the corporate side, Alphabet's Isomorphic Labs captured the spotlight with Eli Lilly and Novartis partnerships, while NVIDIA became integral to the AI drug discovery ecosystem with its computational resources. Partnerships are still crucial to pushing the space forward, with a recent example being Gilead partnering with Genesis Therapeutics for new small-molecule drugs.

Real-world progress

Biotech startups have made significant progress in using AI-powered platforms for drug discovery with drugs in late-stage clinical trials but have not shown them to be superior to the traditional way. This demonstrated that it is possible to take AI-generated drugs to the clinic, but approvals or exits are still an ongoing challenge. However, AI-driven platforms for de novo drug design are still promising. These platforms use generative models to create novel molecular structures with desired properties, significantly reducing the time required for lead optimization. Next-generation products focus on complex biologics that potentially enable the treatment of chronic diseases and difficult cancers. The success of these startups is often linked to their ability to form strategic partnerships with established pharmaceutical companies, access to high-quality datasets, and large cash reserves with strong investors to move multiple drugs forward in the clinic.

Select biotech companies

Company	Last financing date	Total raised ($M)	Last known valuation ($M)	Last financing deal type
AbCellera	January 1, 2021	$671.2	$5,311.3	Public investment second offering
Xaira Therapeutics	April 24, 2024	$1,000.0	$2,700.0	Early-stage VC
Recursion Pharmaceuticals	June 26, 2024	$1,305.9	$2,505.0	Public investment second offering
insitro	April 7, 2021	$643.2	$2,500.0	Late-stage VC
XtalPi Technology	June 13, 2024	$733.6	$2,303.1	IPO
Generate:Biomedicines	September 6, 2023	$693.0	$2,000.0	Late-stage VC
Valo	October 28, 2022	$595.0	$1,350.0	Late-stage VC
Insilico Medicine	June 27, 2023	$427.5	$895.0	IPO
Iambic Therapeutics	June 4, 2027	$209.4	$390.0	Late-stage VC
EvolutionaryScale	June 25, 2024	$182.0	$200.0	Seed

Source: PitchBook • Geography: Global • As of June 30, 2024

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Digital health

Prior expected impacts

In our previous report, we identified care management, behavioral health, and personalized medicine as areas within digital health that could see a short-term impact from recent advancements in AI. New AI technology has been impacting these healthcare areas, though in line with our predictions, we have not yet seen widespread adoption of GenAI into patient-facing digital health platforms. We continue to believe it will take longer to see significant integration of GenAI into patient-facing digital health than it will in the provider-facing healthcare technology markets.

Reality one year later

Today, few patients have interacted directly with AI technology for clinical care as the adoption of consumer-facing AI technology remains relatively low. Many aspects of digital care, such as telemedicine and health coaching, cannot be fully replaced by AI, and even if AI could mirror the service provided by human physicians, regulators and payers would be unlikely to approve these functions for clinical use at the present time. Hippocratic AI, an early leader in bringing GenAI directly to patients, has made strides in building LLMs specific for patient care in areas such as pre-op, discharge, chronic care management, and nutrition. Still, in a sign that GenAI for diagnostic purposes may not be on the short-term horizon, Hippocratic has been clear that it does not believe the technology is currently safe enough to deliver functional and reliable diagnostics.[29] We are bullish about the long-term potential for AI, in combination with other emerging technologies such as digital twins and advanced virtual care, to deliver useful personal health guidance and lead the next wave of digital health innovation.

Real-world progress

Three of the key GenAI applications in digital health that we have been watching are care search and navigation, virtual musculoskeletal (MSK) care, and mental health care delivery. Online care search broadly has changed very little over the past decade, as major search platforms need precise inputs and often also require the filtering of unneeded results. GenAI appears set to revolutionize online search through its probability-based output engines, and we expect a similar change to also affect online healthcare search. Virtual physical therapy and MSK platforms have long integrated AI into their digital programs, and there has also been recent integration of GenAI. For example, symptom checker and care search startup Buoy Health has successfully implemented AI into its core business model, which combines symptom analysis with care search and guidance, and startup K Health offers AI-powered symptom checkers as a method to direct patients toward platform-affiliated clinicians.

29: "Safety Focused Generative AI for Healthcare," Hippocratic AI, n.d., accessed September 17, 2024.

We have seen AI emerge in the care coordination and navigation space—a sector differentiated from care search, as navigation also includes more advanced services such as benefits management, claims assistance, and point solution referral. Healthtech unicorn Transcarent recently launched WayFinding, a GenAI-powered care support and guidance platform, as the startup emerges as a leader in AI-powered navigation. Other established care navigation platforms such as Quantum Health have been using AI on the back end to support human care coordinators and more accurately predict benefits utilization. Over time, consumers are likely to become more comfortable interacting with AI chatbots for their care navigation needs; however, we still see an important role for human care coordinators leveraging AI on the enterprise side, as many patients may still prefer human interaction to understand their complex care and benefit needs.

In June, Sword Health launched Phoenix, a conversational AI that guides patients through virtual physical therapy sessions. This type of AI implementation provides a model for other digital health companies to follow, as Phoenix allows for two-way communication, enabling the patient to provide feedback and adjust session difficulty in real time. In our view, two-way communication will be a key aspect of digital health AI that evolves AI applications from information tools to those delivering truly personalized programs, and we expect other digital health companies to launch similar technologies soon. And in the MSK category, fellow startup Hinge Health offers a program built on AI-powered computer vision, and we expect Hinge could eventually offer a GenAI service to match Sword Health's recent offering as the virtual MSK space remains highly competitive between these two startup players.

Finally, as we wrote in our overview of mental health chatbots in the Q1 2024 Digital Health Report, there is growing recognition that popular GenAI tools are being used for mental-health-related purposes without direct clinical supervision. This runs the gamut from using LLMs to combat loneliness to asking GenAI questions about how to deal with difficult personal situations. In contrast, formalized, dedicated mental health chatbots allow users to engage with an AI agent intended for mental health care that can ask probing questions and provide guidance on cognitive behavioral therapy exercises.

Founded in 2015, India-based startup Wysa has been an early mover in this space. The company has engaged with over 5 million users across 95 countries and currently has partnerships with major organizations including L'Oréal, Aetna, and Britain's National Health Service. Other startups in the space include San Francisco-based Woebot Health ($129.4 million raised) and London-based Limbic ($21.8 million raised). While mental health chatbots remain a niche service, if they can achieve meaningful scale, these tools could be effective in reaching patients in underserved areas with long waitlists for mental health providers. Still, formal implementation of mental health chatbots as an extension of provider practices will require meaningful safety guardrails and the possibility for human intervention. There have also been advancements in using AI to deliver personalized mental health care by improving the provider match process. Employer mental health care company Spring Health operates a platform that uses AI to match patients to providers and identify ideal mental health care pathways based on personal care data and anonymized data on patient outcomes.

Select AI digital health companies

Company	Last financing date	Total raised ($M)	Last known valuation ($M)	Last known valuation step-up	Last financing value ($M)	IPO probability	HQ location
Hinge Health	October 22, 2021	$829.1	$6,200.0	1.9x	$400.0	70%	San Francisco, US
Monogram Health	January 9, 2023	$547.0	$35.0	1.1x	$375.0	66%	Brentwood, US
Spring Health	July 31, 2024	$466.9	$3,300.0	1.3x	$100.0	93%	New York, US
Sword Health	June 4, 2024	$453.7	$3,000.0	1.5x	$130.0	31%	Draper, US
K Health	July 23, 2024	$435.4	$938.4	1.9x	$88.4	91%	New York, US
Transcarent	March 6, 2024	$424.0	$2,100.0	1.2x	$126.0	73%	Denver, US
Flo Health	July 30, 2024	$299.5	$1,000.0	3.0x	$200.0	29%	London, UK
Twin	October 19, 2023	$266.0	$548.7	0.6x	$51.6	65%	Mountain View, US
Woebot Health	March 15, 2022	$129.4	$230.0	1.9x	$9.5	16%	San Francisco, US
Buoy Health	December 1, 2022	$67.6	$191.5	2.1x	$0.1	6%	Boston, US

Source: PitchBook • Geography: Global • As of September 13, 2024
Probability data is based on PitchBook VC Exit Predictor methodology.

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Healthcare IT

Prior expected impacts

In our 2023 note, we identified ambient clinical documentation as the first scalable application of AI in healthcare IT. That assessment has been clearly borne out, with the AI scribing market, which includes both ambient documentation and more straightforward voice dictation applications, becoming extremely crowded and drawing in significant funding. We also predicted that progress toward AI-assisted (and ultimately AI-led) clinical decision-making would occur slowly, with initial progress being made in relatively straightforward operational applications, including patient engagement, call centers, and certain revenue cycle and operational workflows.

Reality one year later

One of the key changes in the AI scribing market is that Abridge has dethroned incumbent Nuance as the clear front-runner, bringing in over $180 million in three funding rounds in 2023 and 2024. In general, adoption of AI scribing among doctors has been enthusiastic because it significantly reduces "pajama time," the industry term for the after-hours task of catching up on required documentation for the day's visits. In addition to the larger enterprise-grade players, myriad low-cost direct-to-consumer solutions have sprung up to meet demand from physicians in smaller or independent practices.

Three main questions about AI scribing are percolating through the industry:

1. **How commoditized will AI scribing become?** At present, AI scribing products range from around $20 per user per month for a no-frills voice dictation app to several thousand dollars for Nuance's full-service (human-in-the-loop) DAX, with most of the "pure AI" ambient scribes falling in the range of a few hundred dollars. The market is crowded with incumbents, well-funded startups, and other software companies spinning up their own add-on products; as quality improves across the board, downward pricing pressure seems inevitable. It is possible that some players may be able to differentiate based on quality and integration and sell at a slightly higher price point to higher-margin service lines such as orthopedics and cardiology—depending on the answer to the second question.

2. **Will Epic ultimately crown (or make itself) the winner?** Epic currently appears to be hedging its bets, partnering with both Nuance and Abridge. Epic has not been acquisitive but does have an internal AI development team—not to mention unparalleled access to training data—and could easily spin up its own scribe. Epic's power among larger and academic health systems means the company could easily decide the fate of AI scribes in the market that is most likely to pay up for premium products.

3. **As documentation improves, what tools will allow providers to make better use of that documentation at the point of care?** This question is the most interesting in our view. Assuming a future in which AI-generated and enhanced clinical documentation becomes commonplace, providers, claims reviewers, and other human experts will be faced with an overwhelmingly large volume of documentation whenever they review a patient's file, including at the point of care. We believe the logical next step will be toward analytical overlays that surface relevant information from a patient's file and, eventually, make diagnostic and treatment suggestions. Companies such as Innovaccer, Navina, Regard, and Vim offer point-of-care tools. Atropos Health is taking a different approach by using GenAI to create publication-grade clinical data analyses to answer specific questions.

On the payer side, rising administrative costs and shrinking margins are pushing many to consider AI workflow enhancements. However, there are material risks at play. UnitedHealthcare and Cigna both currently face lawsuits over their use of AI to make claims approval/denial decisions. Another challenge is the disconnect between payment models for payer tech and services, which are traditionally priced on a per-member-per-month basis, and the volume-based costs incurred by GenAI technology companies. As a result, buyers may question the long-term viability of the solutions being pitched to them. Finally, many payers are worried about second-order implementation costs for AI solutions, including cloud service upgrades and data integration. We expect payer AI adoption to proceed, but cautiously.

Real-world progress

Outside of the relatively narrow use case of AI scribing, adoption of GenAI in healthcare IT has been modest and piecemeal, with most visible progress coming in the form of enhancements to existing products and back-office processes, in line with our previous predictions.

As we discussed in the previous note, healthcare AI adoption is hindered both by a large "trust gap" and by limitations in data infrastructure. It is also important to recall the vertical's broader funding context. The healthcare IT VC funding ecosystem has been stagnant relative to historical levels for more than two years now, with the capital that is being deployed increasingly concentrated in later-stage rounds. One of the biggest problems for healthcare IT—other than the broader post-pandemic market correction—has been the reticence of health systems, the largest customer category for healthcare IT software, to buy anything remotely resembling a point solution. In a difficult financial environment, with sales cycles that regularly extend to 12 to 18 months or beyond and complex integration processes, it can be difficult to justify the risk of working with a VC-backed startup—especially when a roughly equivalent solution is available as an add-on module to the electronic health record (EHR).

Therefore, although many health system chief information officers/chief technology officers are prioritizing AI strategy, they are extremely risk-averse when it comes to buying AI products. We expect many health systems to experiment with homegrown AI solutions and/or to default to AI-enabled features within their existing EHR. This creates opportunities for cloud providers and consultants that offer support for "AI transformation," as well as for incumbent software providers building out new AI product offerings. It also means that winners and losers among AI healthcare IT startups will be decided relatively quickly, with many point solutions becoming M&A targets at a relatively early stage.

Some of the most potentially transformative work is being done at a foundational level by companies such as Hippocratic AI and HOPPR, which are building healthcare-specific LLMs, and by companies such as Evidium, Glass Health, Kahun, and Xyla, which are creating knowledge graphs and referenced ontologies that allow LLMs to be grounded in reliable, explainable medical literature. However, it will take some time to see whether this work will bear fruit in the form of faster and more advanced AI adoption in healthcare IT.

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Medtech

Prior expected impacts

We had not anticipated a dramatic shift in the near-term use cases for AI in medtech based on recent developments, as AI has long been used in patient monitoring, diagnostics, medical imaging analysis, and the surgical arena. And the technology is already well established in health and patient monitoring in areas such as heart health (EEG and ECG), where AI can identify and predict cardiac events, and in the hospital setting, where AI-powered systems monitor vital signs and alert providers to urgent patient needs. More recently, AI has also emerged as a key component of next-generation precision medicine and in the realm of genetic testing. For example, AI is used to detect circulating tumor DNA via liquid biopsies and to identify courses of treatment in precision oncology. There are also medtech-adjacent applications for GenAI, such as treatment planning, data management, and sales efforts, though these applications are generally at the enterprise level and are a closer comparative match with the B2B and provider-facing technologies in the healthcare IT vertical.

Reality one year later

Recent advancements in AI may enable the earlier detection of major diseases such as cancer, Alzheimer's, and Parkinson's, and better screening for these conditions could have a meaningful impact on patient outcomes and care costs. Leading university researchers have published compelling studies on how AI can detect neurodegenerative diseases such as Alzheimer's and Parkinson's years ahead of current diagnostic timelines.[30, 31] And in the emerging category of whole-body MRI screening, startups such as Prenuvo and Ezra Health are using AI to check for several hundred distinct diseases and health conditions. ML has also powered significant technological advancements in cancer screening and precision oncology through blood test liquid biopsies; over the past year, advanced AI has been implemented into established precision medicine tests, such as Guardant Health's Guardant360 diagnostic test.[32]

Real-world progress

Even with the emergence of these new technologies, most cancer screening is currently done through traditional methods such as standard imaging tests and tissue biopsies, partly due to the novelty of new testing methods and also because of the current lack of regulatory approvals and payer coverage. While current screening methods do often produce reliable results, AI screening can enable earlier disease detection, and early detection can be a major factor in improving patient mortality rates and reducing overall care costs to both the patient and payer. Looking ahead, we expect to see a proliferation of AI-powered tests over the coming decade; however, considering the often lengthy regulatory and payer coverage timelines in medical diagnostics, it is likely to take several years before AI-based diagnostics become a core part of regular patient screening guidelines.

30: "The AI Revolution That Could Slow Parkinson in Its Tracks," NeurologyLive, Neal K. Shah, April 19, 2024.
31: "How AI Can Help Spot Early Risk Factors for Alzheimer's Disease," University of California San Francisco, Victoria Colliver, February 21, 2024.
32: "Guardant Health Introduces Guardant Galaxy™ Suite of Advanced AI Analytics to Enhance Its Portfolio of Cancer Tests and Accelerate Biomarker Discovery," Guardant Health, January 31, 2023.

While automation has been used in ECG monitoring for decades, recent advances in AI have enabled AI-based systems to more effectively analyze heart data, predict acute cardiac events, and improve data interpretation. In 2021, the first randomized clinical trial of AI-enabled ECGs compared with the standard of care was completed, and this study showed meaningfully improved diagnostic results.[33] Emerging leaders in the AI-powered ECG category include startups AliveCor ($307.6 million raised) and Powerful Medical ($8.0 million raised), as well as iRhythm and HeartSciences in the public sector. Beyond cardiac monitoring, AI is increasingly being used in tandem with wearables for remote patient monitoring in hospital-at-home, post-discharge, and chronic condition programs. The rising consumerization of healthcare also has relevance in AI patient monitoring, considering the ambitions of large consumer tech companies to provide clinical-grade health tracking capabilities. Glucose levels, blood pressure, heart rate, temperature, and oxygen levels are all major vital signs that could benefit from the use of AI to improve remote health monitoring. Over the longer term, we expect regulatory bodies such as the US Food and Drug Administration to approve more consumer applications for AI-based monitoring and diagnostics, and as this occurs, there will be greater opportunity for both startup companies and established market players to leverage AI for future growth opportunities.

33: "The Emerging Role of Artificial Intelligence Enabled Electrocardiograms in Healthcare," BMJ Medicine, Arunashis Sau and Fu Siong Ng, July 31, 2023.

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