Microsoft | Microsoft for Startups

AI in the Early-Stage Venture Ecosystem

2024

Executive summary

This white paper explores how multibillion-dollar deals as well as broader venture investment trends and macroeconomic factors are accelerating key technological developments and applications in AI. In particular, it explores the health of early-stage VC activity in AI as deal metrics maintain records despite a volatile macro backdrop and higher interest rates.

- **Venture investment in AI continues to defy significant slowdowns induced by market volatility and shaky economic growth.** Worldwide, close to 1,800 transactions have closed thus far in 2024 for an aggregate of $21.1 billion. Outlier deals still skew quarterly tallies of VC invested. 2023 figures for VC invested are skewed by OpenAI's $10.0 billion deal, while other megafinancings for companies such as Anthropic and Mistral AI appear in monthly financial breakouts.

- **Founders and investors are moving upstream in the AI ecosystem toward earlier-stage and/or novel subsegments as key arenas are dominated by incumbents.** Generative AI and other large language model (LLM) arenas are dominated by fast-ramping first movers. As a result, early-stage VC activity is resilient as investors look to fund other AI segments and applications. Different AI approaches such as reinforcement learning from experts, synthetic data generation, and convolutional neural networks are being explored and funded in tandem with novel applications in biotech, energy, and more.

- **This type of cycle is common in many industries, but the growth rate of AI has been turbocharged given its unique nature.** Thus, funding activity has been frenetic in key AI subsegments, particularly around general-purpose tools and platforms. The next waves of bullish enthusiasm will be more concentrated in applications and infrastructure, especially with particularly deep, fruitful market opportunities, such as in healthcare expenditure savings or energy grid monitoring.

- **Policies and consequent concrete regulations are slowly being realized across major economies, with the European Union's AI Act and draft legislation by China serving as two primary examples.** As seen in certain

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other industries, it is likely that AI regulation will evolve to prioritize national security concerns across aligned geopolitical actors. Underlying information relied upon by many AI approaches remains unconstrained or potentially even unregulable. These changes represent market-entry opportunities for AI startups to develop more transparent, secure models that can improve the quality of deployment in different applications.

- **Armed with plenty of capital infusions from VCs and corporates, AI startups can target significant opportunities in frontier applications.** Given the speed with which incumbents are gaining commanding market positions in some AI segments, prioritizing rapid product-market fit in blue-ocean areas will be key. Classic business and market challenges will still be in place, although AI scaling and funding has been resilient thus far in a relatively volatile market. Some startups are likely to succeed given the proven strengths of their current AI models, even prior to any subsequent innovation and improvement in their functions. As of now, the early-stage AI startup ecosystem is flush with sufficient capital to pursue the development of new AI models or optimize extant models into much more actionable, scalable tools.

Macro trends

PitchBook emerging technology analyst Brendan Burke identifies vertical applications and horizontal platforms as two prominent groupings with which to examine and organize the AI industry.[1] In short, the current state of the field can best be viewed through two lenses—intra-AI and external applications—and the two are not necessarily mutually exclusive. Below are a few examples of key challenges and applications that showcase the current state of the industry.

Challenges—and opportunities

- **Ethical concerns:** The utilization of mass data to train LLMs has been well analyzed to the point that mitigating any inherent bias in training datasets is a basic module in introductory AI or machine learning (ML) courses. As generative AI solutions in particular grow in power and scope, ethical concerns are set to intensify. We recently saw yet another academic inquiry into the ethics of data scraping for generative AI,[2] and the pope even called to establish a universal framework for AI ethics at an upcoming G7 summit dedicated to AI.[3] Companies cannot afford to remain unaware of the evolving frontier of ethical concerns, as these concerns may eventually translate into more critical regulations, much like consumer privacy issues led to the General Data Protection Regulation, California Consumer Privacy Act, and other policy shifts. What may be lesser-remarked now is that any ethical concerns also present a business opportunity, in that more transparent and still-efficacious AI solutions for companies can tout their greater adaptability to any new guidance on fair usage. Businesses such as Credo AI will double down on emphasizing transparency and security. Even at earlier stages, companies such as Holistic AI, which provides a modular AI governance platform for functions such as risk mapping, are targeting layers of reporting for compliance and other regulatory needs.

- **Policy:** Although the European Union's AI Act has been arguably the most discussed in the field as of late, China's AI regulation is likely to be finalized soon. An MIT Technology Review article summarized the primary areas that the Chinese AI law is likely to address, including which third parties are likely to review AI applications and underlying data and models, plus areas that companies should avoid targeting.[4] The draft legislation does not contain many other surprising aspects,[5] as it emphasizes the development of an AI ecosystem, literacy, insurance services, and more, all to provide more frameworks for AI innovation while still aligning to existing regulatory strictures. The European Union's AI Act, while derived from more classical Western legal frameworks, aims to do much of the same. A recent publication by law firm Norton Rose Fulbright summarized the act's goals: 1) classify risk levels of AI applications and companies' usage, 2) raise awareness, 3) establish governance, and 4) better explain and promote AI applications and tools so that their full implications can be understood by even laypeople.[6] For early-stage AI companies, the essential takeaway from this wave of regulations is that compliance is coming in myriad forms—and awareness will be critical to avoid unexpected penalties.

- **Data, infrastructure, and security:** Anecdotes are already popping up amid more general concerns that LLMs are experiencing significant diminishing returns. For example, GPT-4 Turbo saw only a 2% gain in the Massive Multitask Language Understanding (MMLU) benchmark.[7] It is worth noting that GPT-4o did notch a couple percentage points to 88.7 on MMLU.[8] As pointed out in numerous publications, a key issue for the most popular AI tools—LLMs—is their lack of higher reasoning beyond brute-force statistical association.[9] This higher reasoning remains elusive for now but may eventually

1: "Q4 2023 Artificial Intelligence & Machine Learning Report," PitchBook, Brendan Burke, February 27, 2024.
2: "Traversing the Ethical Landscape of Data Scraping for AI," SSRN, Jayasankar Jayachandran and Vijay Arni, December 8, 2023.
3: "Pope Francis to Advocate for Ethical AI at G7 Summit in Italy," UPI, Simon Druker, April 27, 2024.
4: "Four Things to Know About China's New AI Rules in 2024," MIT Technology Review, Zeyi Yang, January 17, 2024.
5: "Artificial Intelligence Law," China Law Society, March 18, 2024.
6: "Preparing for Change: How Businesses Can Thrive Under the EU's AI Act," Norton Rose Fulbright, April 2024.
7: "Evidence That LLMs Are Reaching a Point of Diminishing Returns—and What That Might Mean," Gary Marcus, Marcus on AI, April 13, 2024.
8: "GPT-4o vs. GPT-4 vs. Gemini 1.5 — Performance Analysis," Medium, Lars Wiik, May 13, 2024.
9: "Characterizing Generative AI, Circa 2023," Medium, Kentaro Toyama, November 12, 2023.

be found in combining other AI approaches. Generative AI often presents this issue, potentially because most of its commonly known approaches have to tackle extraordinarily vague parameters and mandates, which would stymie most conceptual frameworks. Other AI approaches face different challenges. Computer vision remains promising but relies on well-labeled data, as seen with AI in minimally invasive surgery.[10] Natural language processing for sentiment analysis also requires correction depending on the types of models or data used.[11] One of the more popular types of deep learning networks, convolutional neural networks, still faces all the issues common to its statistics-rooted mechanisms, including those of overfitting and underspecification. These extant issues are often the exact focus of frontier AI applications, while current mitigation strategies often utilize expert calibration and reinforcement learning in tandem to improve overall performance. Shifting approaches to initially train on much smaller yet higher-quality datasets before extrapolation or utilizing better-curated synthetic datasets have become popular areas of focus. Last but not least, security concerns are set to become a ripe field for startups to tackle. For example, Cranium is an early-stage startup that provides both compliance reporting and adversarial monitoring to provide greater visibility across AI systems.

Select frontier applications

- **Mobility & manufacturing:** Although challenging and still nascent apart from their use in analytics, deep learning techniques are being utilized in intelligent transportation applications as more and better-quality datasets are gathered from widespread and growing sensor usage.[12] Smart parking management, driver identification, vehicular network security, and more are all key arenas for innovation. Advanced manufacturing is also seeing increases in AI testing, although concerns remain around widespread deployment. However, some companies are piloting and seeing some success (such as in real-time spot weld quality prediction).[13] Advanced manufacturing and supply chain tech companies have thus raked in $7.2 billion in venture funding since 2020 as more practical and realizable use cases have emerged.

- **Data management and maintenance:** As seen in the following case study on Unstructured, effectively utilizing all the extant data that a business gathers is often best suited for AI tool suites that can automate query priority, database administration, or data presentation for swifter cleaning, labeling, and processing. Database software has attracted just $1.2 billion in early-stage venture funding from 2020 to 2024 YTD, likely due to some competition from entrenched database tech giants' AI-specific efforts, but significant opportunity for innovation remains.

- **Generalizability:** Companies such as Mistral AI and others utilizing open-source models are focusing on building multiple types of basic applications that then can be modulated for different end applications. Hurdles include increasing specification for more niche end cases, but that will most likely emerge only within domain-specific enterprise AI models as they are built by different startups. Closed-source applications, such as Duolingo's use of natural language processing to convert text to speech for character voices,[14] are other early examples of how AI applications will be greatly customized.

- **Theoretical research:** Many biotech applications of AI are at the nexus of theoretical and actual commercial applications, hence why biotech has seen healthy rates of venture funding: $5.3 billion from 2020 to 2024 YTD relative to $1.2 billion for database software. However, theoretical research may be an even more groundbreaking arena for AI deployment. A serviceable example of AI's application to theoretical research is the usage of AI to map string theory networks to larger particle-based theories.[15] However, other scientific domains are seeing significant upticks in the usage of AI programs, including to help better model hypothetical molecular structures or map cellular functions. For example, a recent feature story cited how an AI analysis of cell nucleus changes was able to improve accuracy in the prediction of cellular death.[16] Much of AI's promise in these realms is in improving pattern recognition beyond the scales of human intellect while presenting improved syntheses for superior human reasoning to process.

10: "Artificial Intelligence-Based Computer Vision in Surgery: Recent Advances and Future Perspectives," Wiley, Annals of Gastroenterological Surgery, Daichi Kitaguchi, et al., October 8, 2021.
11: "Natural Language Processing in Electronic Health Records in Relation to Healthcare Decision-Making: A Systematic Review," ScienceDirect, Computers in Biology and Medicine, Elias Hossain, et al., March 2023.
12: "A Survey on the Applications of Frontier AI, Foundation Models, and Large Language Models to Intelligent Transportation Systems," International Conference on Computer and Applications, Mohamed R. Shoaib, Heba M. Emara, and Jun Zhao, January 12, 2024.
13: "Unlocking Value From Artificial Intelligence in Manufacturing," World Economic Forum, December 2022.
14: "Duolingo Makes Learning Language Fun With Help From AI — #LaunchWithAI," Duolingo, Nandita Jaya, February 23, 2023.
15: "AI Starts to Sift Through String Theory's Near-Endless Possibilities," Quanta Magazine, Charlie Wood, April 23, 2024.
16: "How AI Is Shaping Scientific Discovery," National Academy of Sciences, Sara Frueh, November 6, 2023.

Investment trends

AI VC deal activity by month


Deal value ($B) ——— Deal count
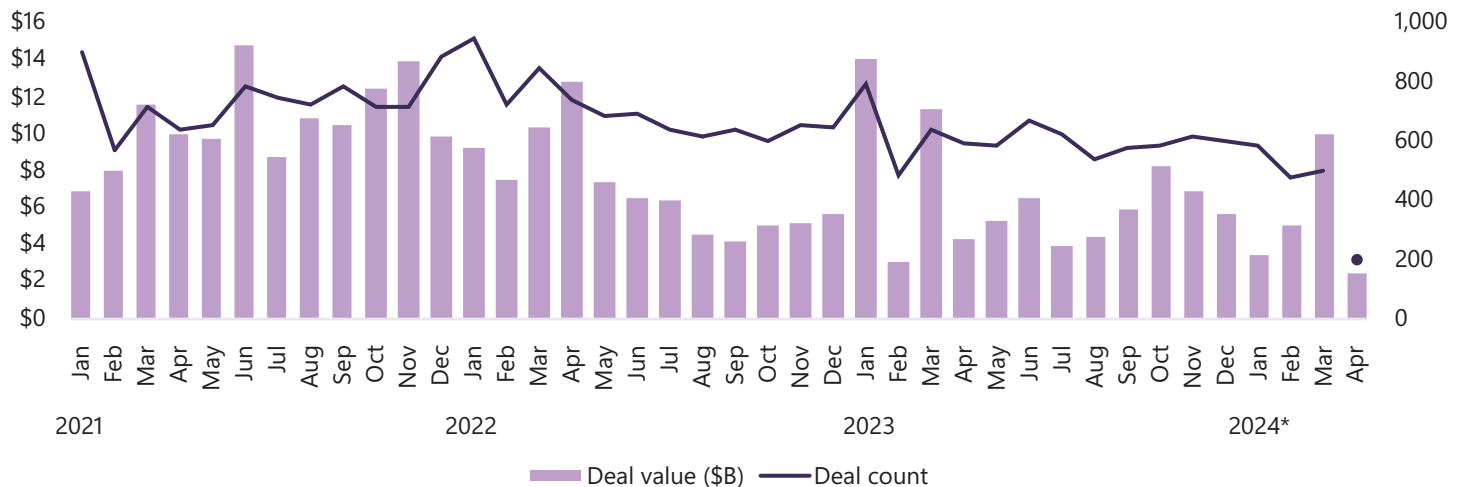
Source: PitchBook • Geography: Global • *As of April 15, 2024

The venture financing environment for AI remains more than healthy

In this section, we juxtapose key findings from our analysis of early-stage venture investment in AI with a quick recap of broader AI dealmaking datasets. Worldwide, venture financing in AI remains robust. 2024 has so far seen $21.1 billion invested across close to 1,800 completed financings, already pacing to the $80.2 billion invested in all of 2023. After the consistent heavy flows of investment in 2021, deal counts have only somewhat subsided while some quarters still show the impact of mega-rounds such as the financings of Mistral AI, OpenAI, and Anthropic. In total, OpenAI has raised $11.3 billion (including corporate rounds; the breakout of VC funding with corporate participation is discussed below); Anthropic, $7.9 billion; Inflection AI, $1.6 billion; and Mistral AI, $528.0 million. That is just $21.3 billion of the $379.4 billion of total VC invested in AI from 2020 to 2024. Beyond larger deals, early-stage (defined herein as pre-seed, seed, and Series A) funding in AI is exuberant, accounting for $4.5 billion across 679 rounds in Q1 2024 alone; by comparison, overall US early-stage VC tallied around $10.2 billion.

AI VC deal activity

Deal value ($B) ——— Deal count
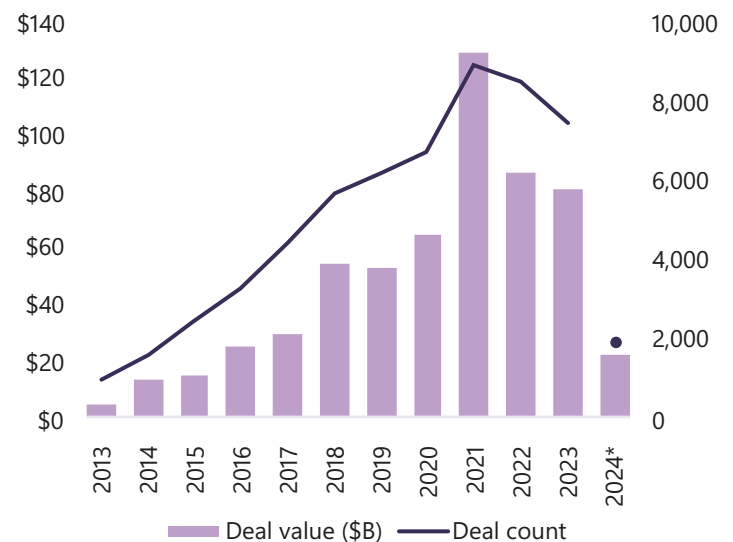
Source: PitchBook • Geography: Global • *As of April 15, 2024

AI early-stage VC deal activity by quarter


Deal value ($B) — Deal count
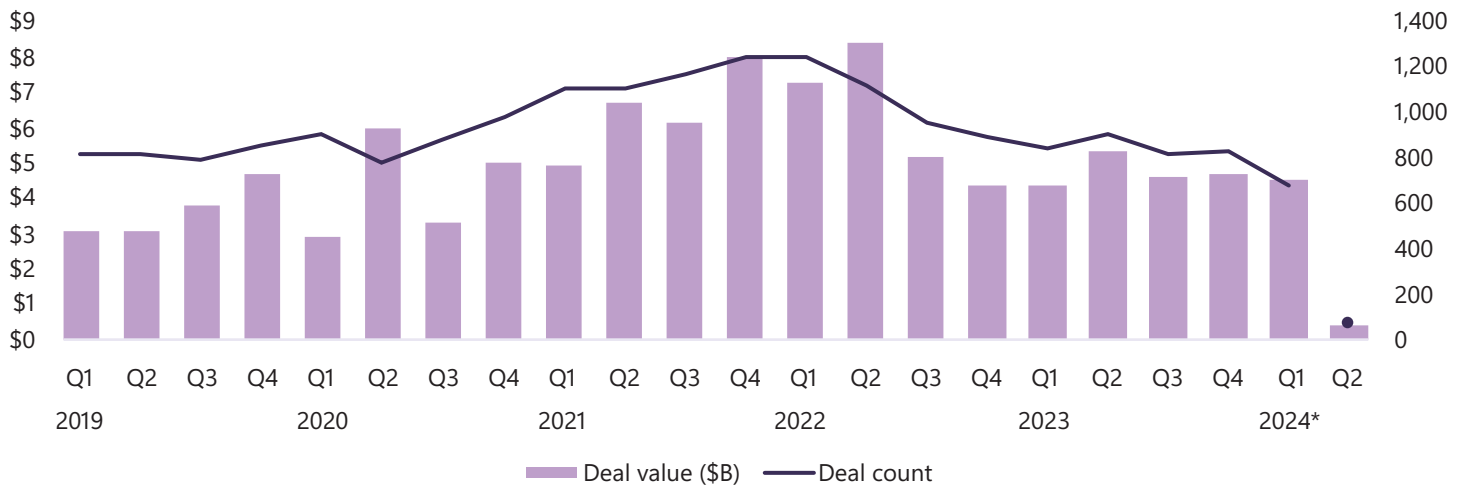
Source: PitchBook • Geography: Global • *As of April 15, 2024

The early-stage funding market for AI startups is even more robust than the general ecosystem

Despite concerns in general VC investing, early-stage dealmaking is the strongest it has ever been apart from the heights of 2021. In 2024 thus far, the median pre-seed, seed, and Series A deal sizes are all at record heights of $1.1 million, $3.0 million, and $12.0 million, respectively. Even the average transaction size, skewed by past outliers, is showing a record high for seed and Series A so far in 2024. As noted in the executive summary, this strength is especially stark when compared with broader market volatility and higher costs of capital thanks to higher interest rates.

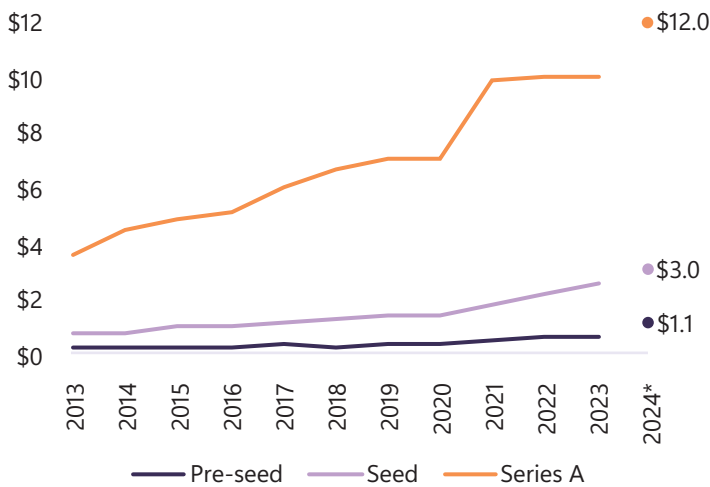## AI early-stage VC deal activity

Deal value ($B) — Deal count
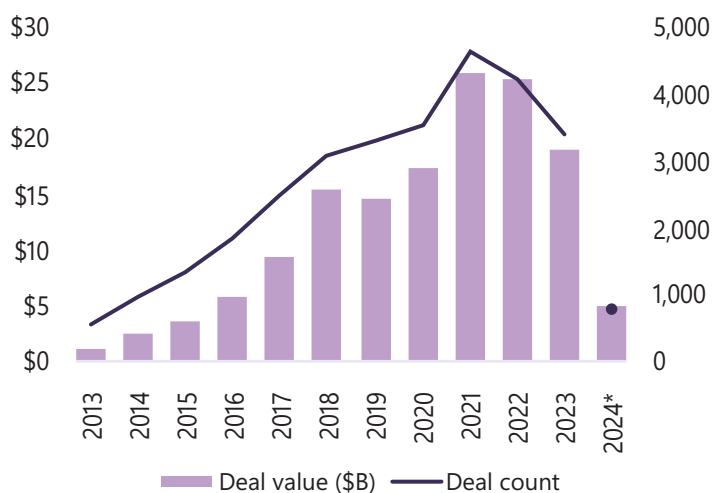
Source: PitchBook • Geography: Global • *As of April 15, 2024

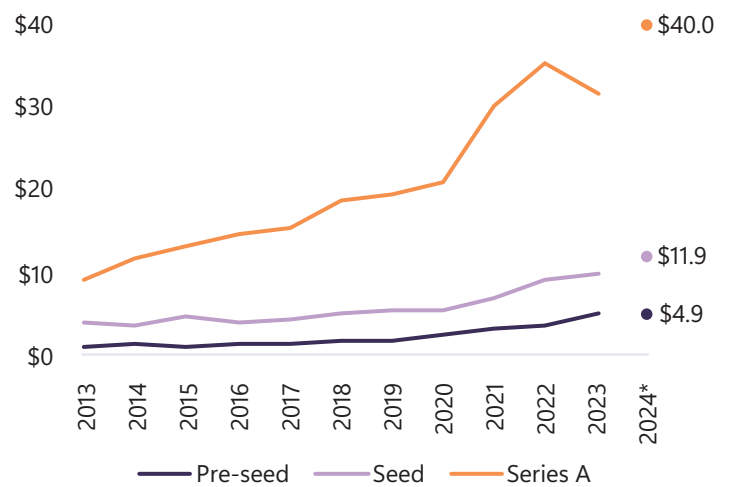## AI VC deal activity excluding deals of $500 million or more

Deal value ($B) — Deal count
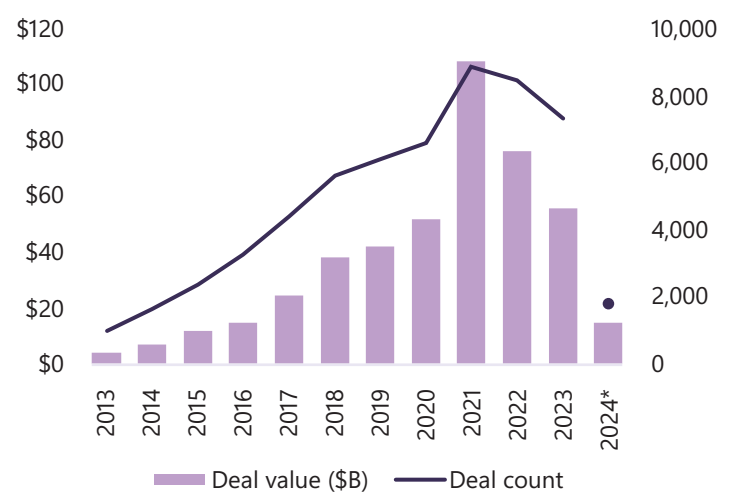
Source: PitchBook • Geography: Global • *As of April 15, 2024
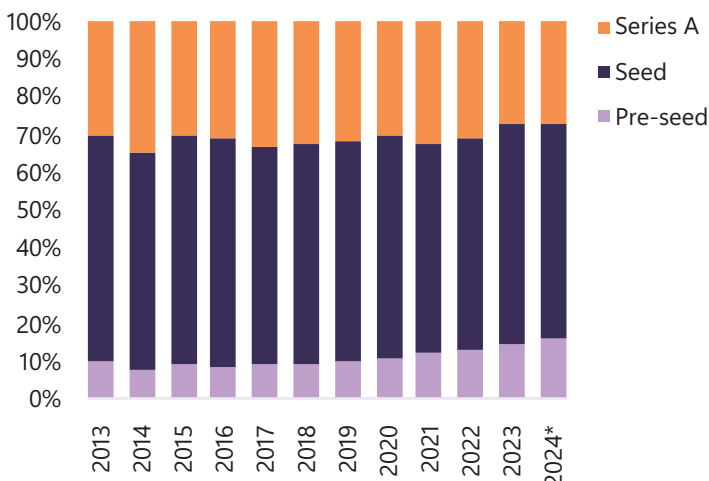
Median AI early-stage VC deal value ($M) by series

- $12.0
- $3.0
- $1.1

Pre-seed — Seed — Series A

Median AI early-stage VC pre-money valuation ($M) by series

- $40.0
- $11.9
- $4.9

Pre-seed — Seed — Series A

A trend toward pre-seed and seed exhibits investors' search for unique value propositions earlier in entrepreneurial funnels

Although pre-money valuations are either setting new records or holding steady—the YTD median Series A valuation is $40.0 million—analyzing deal flow by series helps assess any drift toward an earlier-stage focus, demonstrating investment firms and companies' capacity to close funding even at preliminary stages. Thus far in 2024, there has been a distinct if relatively small uptick in
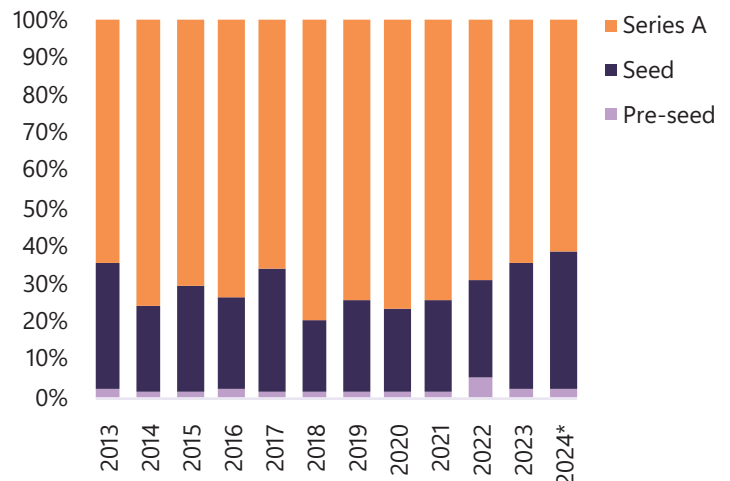
the proportion of venture financings closed in the pre-seed stage. On the other hand, the clearest trend in capital invested is the surge in the seed segment's proportion of overall deal value. Taken in tandem, these trends suggest that although pre-seed remains more variable in total capital invested due to its unique risk prospects, it is growing more popular for investors as they look to the earliest stages of the entrepreneurial funnel to glean unique AI value opportunities. Meanwhile, competition at the seed stage is heating up, hence the surge in its proportion of dollars invested.

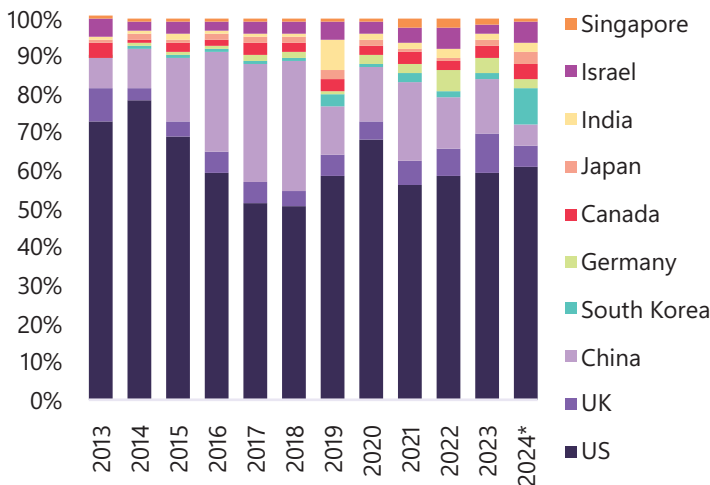## Share of AI early-stage VC deal count by series

Series A
Seed
Pre-seed

Share of AI early-stage VC deal value by series
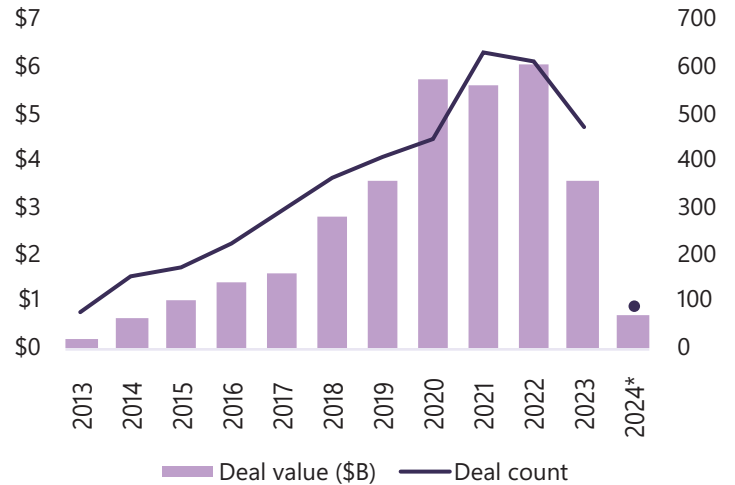
Series A
Seed
Pre-seed

Share of AI early-stage VC deal value by most active countries

Legend (top to bottom): Singapore, Israel, India, Japan, Canada, Germany, South Korea, China, UK, US

Source: PitchBook • Geography: Global • *As of April 15, 2024

AI cross-border early-stage VC deal activity

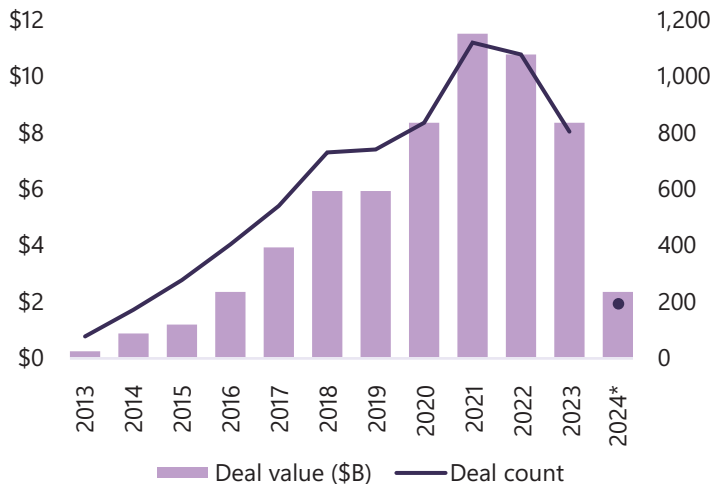Legend: Deal value ($B), Deal count

Source: PitchBook • Geography: US • *As of April 15, 2024
Note: This chart includes US-headquartered companies receiving investment from at least one investor based outside the US.

Government-supported initiatives fuel surges in outlier deals; corporates play key role in helping establish commanding market leads

Certain nations see much higher proportions of early-stage deal flow in AI than others as a result of significant government support and a commanding market lead taken by fast-moving growth-stage companies. A prime example is South Korea's nearly $358 million in deal value in 2024 YTD. Strikingly, even at the early stage, cross-border AI
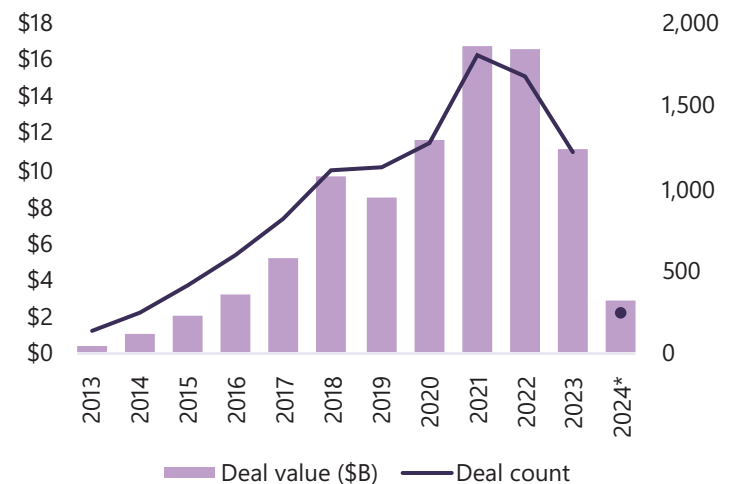
investment rates are healthy, with only a mild slowdown observed in the past 16 to 17 months. This suggests that venture firms are eager for exposure to pockets of AI innovation wherever they can be found. Corporate venture arms are much the same, though they often join in larger rounds, hence their greater proportion of early-stage deal value. The outlier deals for OpenAI and Anthropic noted earlier also show how corporate capital and partnerships are helping turbocharge AI's sector development and get select companies to commanding market positions.

## AI early-stage VC deal activity with corporate venture capital participation

Legend: Deal value ($B), Deal count

Source: PitchBook • Geography: Global • *As of April 15, 2024

AI early-stage VC deal activity with nontraditional investor participation

Legend: Deal value ($B), Deal count

Source: PitchBook • Geography: Global • *As of April 15, 2024

AI early-stage VC deal count by segment
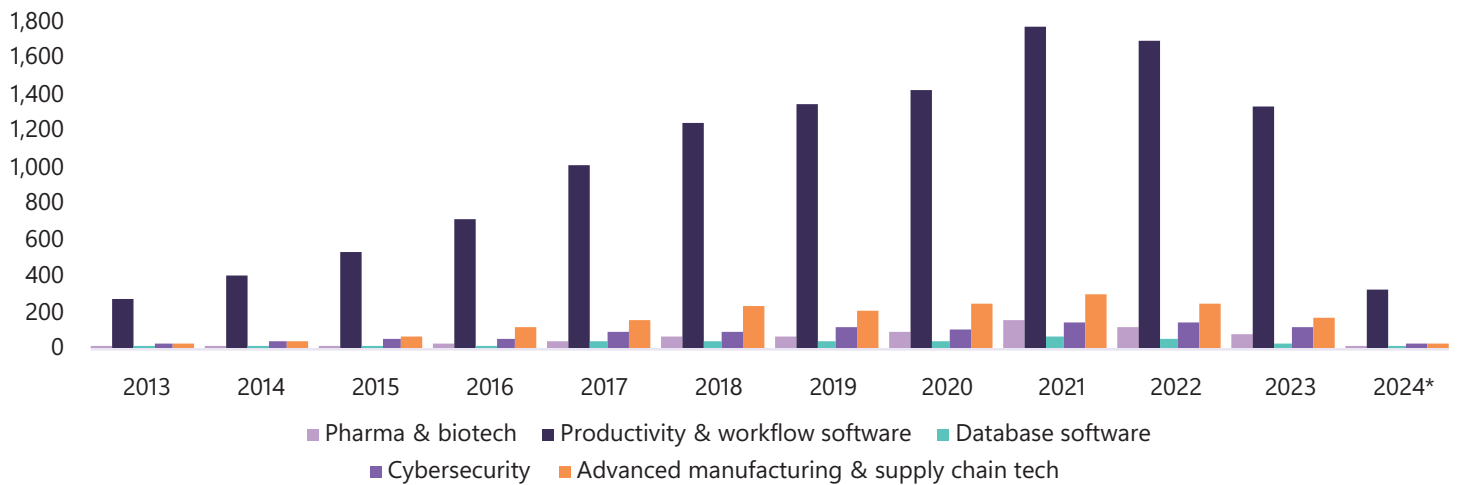
Examining AI dealmaking by segment reveals a key focus on infrastructure and workflow applications

Of the AI segments still seeing considerable funding flows, productivity & workflow software, database software, advanced manufacturing, and supply chain tech (the last two combined in these charts given their relevancy to each other) have attracted more consistent volume.
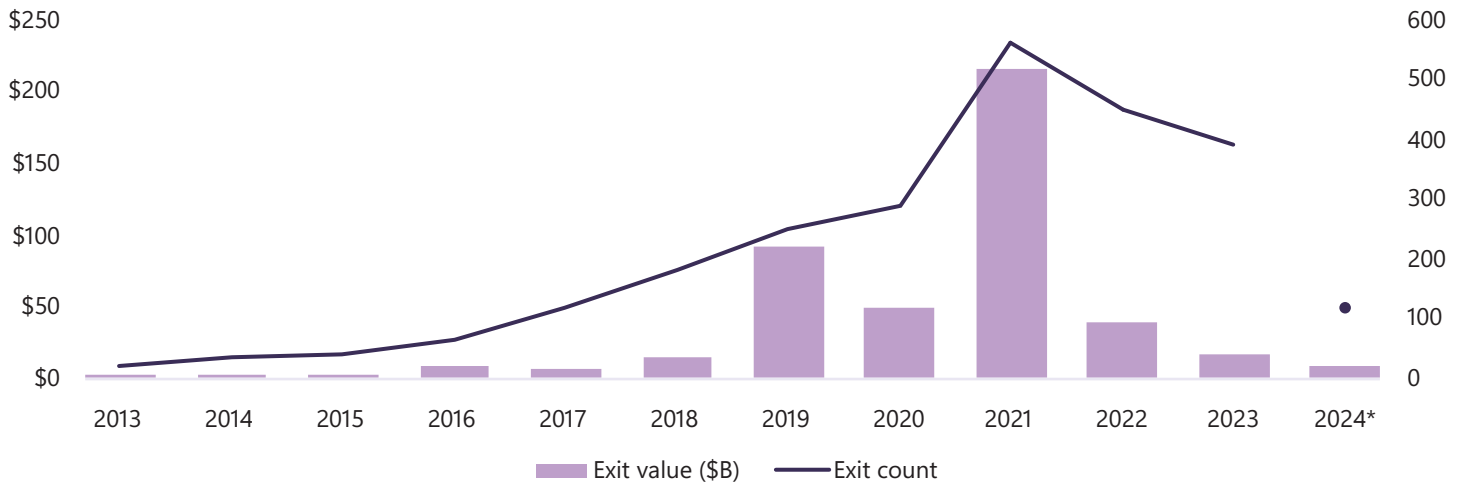
Aggregate deal values are much more skewed to business software overall, yet as we remarked earlier, outliers have driven some of that skew, even at the early stage. As noted previously, the concentration of capital investment in enterprise applications is a hallmark of current AI innovation. Some early movers are raising massive sums to scale faster, and others are expanding into multiple industry niches or generalizable tool suites or focusing on core AI infrastructure.

AI early-stage VC deal value ($B) by segment
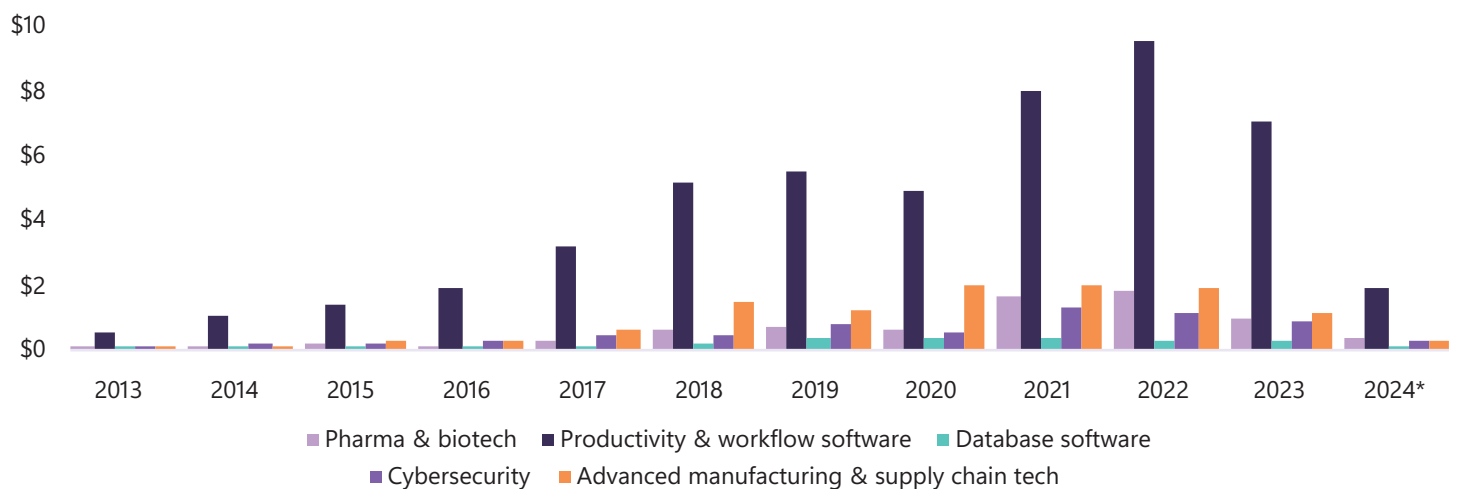
AI VC exit activity
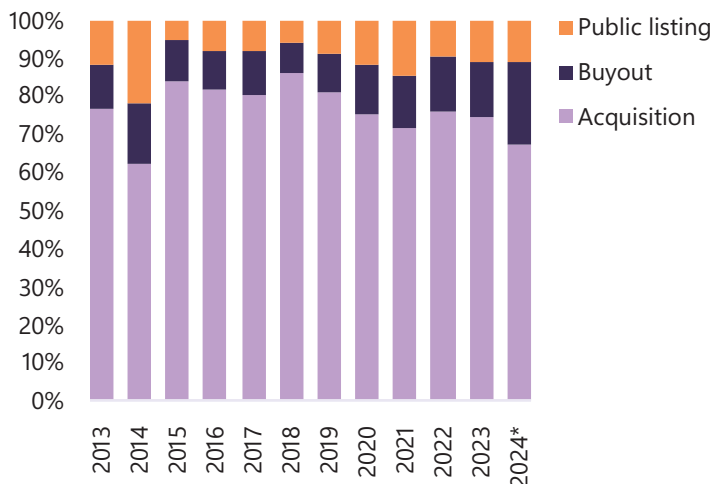

Exit value ($B) — **Exit count**

Source: PitchBook • Geography: Global • *As of April 15, 2024

Liquidity for AI companies remains sluggish since the heyday of late 2021 to early 2022

Because exits by early-stage companies are not that frequent, it is more instructive to look at overall exit rates of venture-backed AI companies. That being said, 47 early-stage businesses have already been acquired or gone public in 2024 YTD. (It should be noted that companies that raised heavily even at early stages may have reached maturity sooner than others due to greater resources.) Since the ebullient market climates in 2021 and early 2022, buyouts of AI companies by PE firms have ticked up in their overall proportion of exits, even as the volume of exits
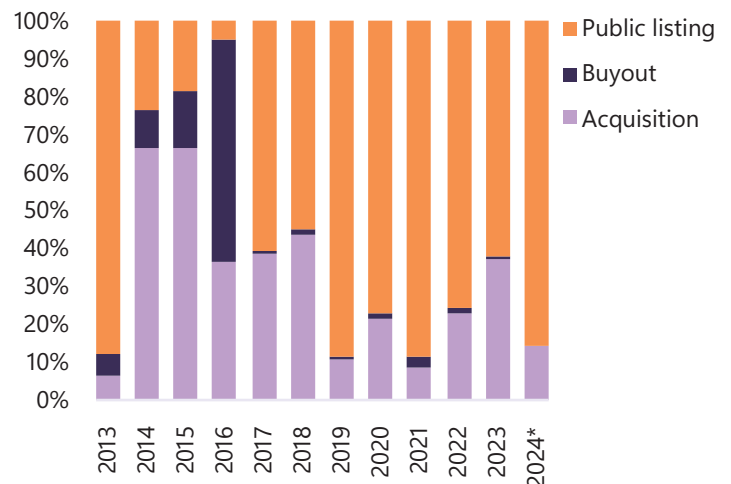
has slowed considerably. Software-focused PE firms that garnered experience and success in the 2010s are growing more active in AI to augment their existing portfolios. For example, 83 public listings occurred in 2021, yet just 42 each were completed in 2022 and 2023, and 12 have been completed YTD in 2024. Thus far, it is difficult to assess if anything is slowing AI exits other than the nascency of the segment, in that only a handful of truly large, mature AI-centric enterprises have not yet exited, and the bulk are building and scaling. Overall market conditions are also contributing to subdued liquidity, as markets remain jittery and M&A is down worldwide.

Share of AI VC exit count by type

Public listing / Buyout / Acquisition

Source: PitchBook • Geography: Global • *As of April 15, 2024

Share of AI VC exit value by type

Public listing / Buyout / Acquisition

Source: PitchBook • Geography: Global • *As of April 15, 2024

Case studies

About

Wallaroo.AI is a downloadable software platform that allows Azure customers to deploy, serve, monitor, and optimize ML via the Azure ecosystem tools they utilize. Wallaroo.AI's enterprise edition enables integration with Azure ML and Databricks Jupyter notebooks, single sign-on, and more. Among other features, it also enables workload orchestration. Ultimately, the company's goal is to deploy and scale production ML to expedite workflows and render them more efficient.

Takeaway

This value proposition aligns with the previously mentioned key focus area of today's AI and ML tooling: infrastructure. Much like how the waves of database and software-as-a-service (SaaS) toolkits in the 2010s drove considerable advances in computational capacity and innovation, a wave of AI and ML infrastructure is now occurring.

Key customers:
US Space Force, Detroit Lions

Learn more at
Wallaroo.AI's website.

About

Unstructured provides tools to help companies prepare their data for LLMs. The company's solution ingests and preprocesses complex natural language data from any document, file type, or layout. Unstructured's engine involves breaking a document into its constituent parts and identifying the document's hierarchy, such as its header, tables, and body text. Its vision transformer can tackle disparate types of datasets across most common company data collection methods and repositories.

Takeaway

For lack of a better term, "clean" data is a critically ramping moat in the intensely competitive field of AI training models, across multiple types of databases and frameworks. LLMs in particular are rapidly increasing in computational cost to the point that improvements beyond the algorithmic level are likely to be found in better-structured, cleaner data.

Learn more at
Unstructured's website
and watch this video.

About

Weights & Biases offers an ML operations platform that helps ML teams build better models faster. Ideally with little upfront work in code, practitioners can instantly debug, compare, and reproduce their models while keeping them intact with all their features, from architecture to model weights to GPU usage. The company's tools help track artifacts and experiments, visualize data and models, and iterate on models across teams.

Takeaway

The company stresses that the collaboration offered by their tool will hopefully help tackle reproducibility and regulatory concerns. This is a budding if not flourishing issue within many academic areas but especially for AI or ML practitioners given that such solutions are eagerly being commercialized and applied live, with real-world stakes. By rendering workflows more collaborative and transparent, the company is taking direct aim at the frameworks of tools required to begin tackling such challenges.

Key customers:
OpenAI, Microsoft, NVIDIA, Cohere, Wayve

Learn more at
Weights and Biases' website.

Looking ahead

Early-stage dealmaking in AI showcases a healthy, resilient level of venture financing flowing to AI infrastructure and applications for multiple end use cases and customers. Although not quite at the heights observed in the most recent venture bull market, early-stage venture dealmaking in AI is healthier than it has been in any other recent period, signifying founders and investors' confidence in the adoption, commercialization, and marketability of many AI-driven solutions. The sheer rate of implementation in customer service, accounting, document review, and other corporate divisions seems to testify to the return on investment (ROI) of contracting or building AI tools customized for specific business needs, especially when these needs align with the best-proven AI strengths: mass data ingestion to more efficiently and expeditiously unearth hard-to-discover or novel patterns, and the duplication of basic patterns of creation, interaction, or research to augment or replace low-level tasks.

However, challenges remain for early-stage AI startups in two primary arenas: 1) technical hurdles for tasks that are complex and computation heavy, and 2) business and target market competition from established and/or well-funded entrants. Hence, a heavy flow of early-stage capital is observed across myriad business applications, but this is best characterized as the first stage of a proliferation across sectors, much like the initial digitalization and subsequent "SaaS-ification" that occurred throughout the 2000s and 2010s. Incumbent AI companies will continue to improve on LLM refinement with entrenched advantages in contracts, funding, and models, yet early-stage companies still have opportunities to drive the innovation frontier of alternative model approaches, synthetic data curation, the identification of novel blends of proprietary datasets to train less-compute-intensive algorithms, and so on. Demonstration of ROI for corporate clients will be a key focus throughout this year due to the level of investment and pursuit of revenue generation that is characterizing the current market environment. Pundits are already noting the leanness of newer AI companies.[17] However, it is likely that

many AI players will see some degree of success in adoption given the existing mid-hanging fruit of manual, rote tasks that can be automated with sufficiently sophisticated AI agents. Risk factors, especially reliability and security, remain key areas of research but are not deal breakers. Certain use cases require near-complete accuracy, which can elude even today's best-in-class tools, but those remain avidly researched to move them from the hypothetical to the concrete. All in all, the early-stage AI ecosystem is primed with sufficient reserves of capital to build even more useful AI solutions that will hopefully tackle this next array of critical challenges.

Top takeaways for startups

1: Product-market differentiation: Prioritize mapping out which greenfield opportunity in AI approaches or deployment you are targeting, and why it is proof against current heated competition.

2: Efficiency: Although the ecosystem is awash with capital, broader economic and market uncertainty means that showing your efficiency in capital allocation will help you stand out.

3: Strategic pathway: Exploring and stating longer-term strategic pathways to either acquisition, listing, or some other longer-term outcome will be critical to demonstrating market intelligence and competitive positioning as well.

17: "AI's Most Promising Startups Are Getting Younger and Leaner," Forbes, Kenrick Cai, April 11, 2024.

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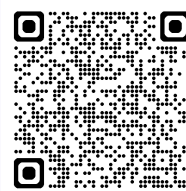
Methodology

Early-stage VC activity is defined as pre-seed, seed, and Series A round types, combined unless otherwise noted. Otherwise, PitchBook's standard report methodologies were utilized. Geography is global. PitchBook verticals were used to define segments and juxtapose them with AI trends. For example, the business/productivity software industry code and the automation/workflow software vertical were utilized to segment the AI vertical and assess investment flows in that particular industry cross-section. Deduplication was not performed on segment breakouts due to potentially erroneous exclusions.