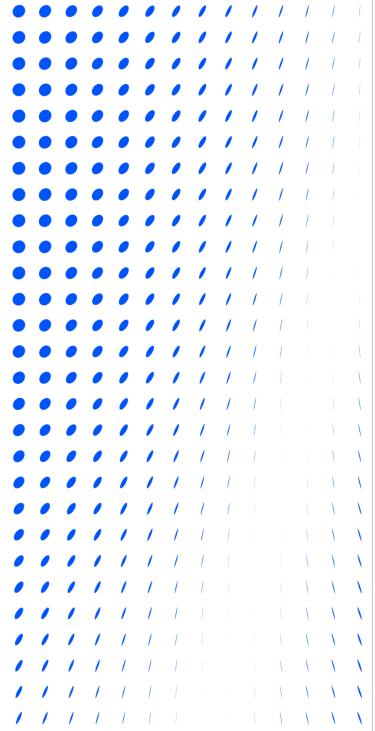
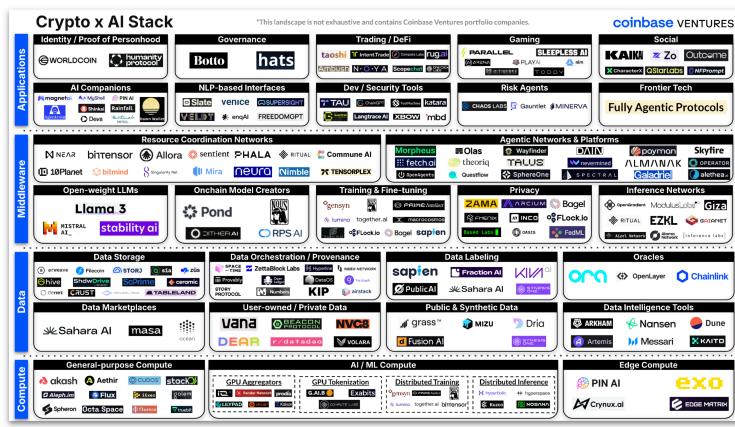


Demystifying the Crypto x AI Stack

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coinbase VENTURES

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Disclosures and footnotes: Coinbase Ventures' portfolio companies are denoted with an asterisk (*) when first referenced in the article below.

The future of AI can be built on blockchain technology, as crypto can help increase accessibility, transparency, and use cases within the emerging tech. The convergence of crypto's efficiency, borderless nature, and programmability with AI has the potential to transform how humans and machines interact with the digital economy, including by enabling users to have sovereignty over their personal data. This includes the rise of the "Agentic Web," where AI agents operating on crypto infrastructure can drive economic activity and growth.

So what does this look like? AI agents making transactions on crypto infrastructure. Software code created by AI, including smart contracts, leading to a surge in onchain applications and experiences. Users owning, governing, and earning from the AI models they contribute to.

Leveraging AI to improve user and developer experiences within the crypto ecosystem, enhancing smart contract capabilities and creating new use cases. And so much more.

As we imagine this crypto x AI future, today [Coinbase Ventures](#) is unveiling our core thesis on the future of this transformative technological convergence. At a glance:

- **We do not believe crypto / blockchain technology is required to advance capabilities or solve emerging challenges in every layer of the AI tech stack.** Rather, crypto can play a major role in bringing more distribution, verifiability, censorship-resistance, and native payment rails to AI, while benefiting from AI mechanisms to power new user experiences onchain.
- **Crypto x AI can give rise to the “Agentic Web”,** a transformative paradigm in which AI agents operating on crypto infrastructure rails can become significant drivers of economic activity and growth. We predict a future where agents will have their own crypto wallets to autonomously transact and fulfill user intents, access lower-cost, decentralized compute and data

resources, or leverage stablecoins to pay humans and other agents to complete tasks necessary for their overall objective function.

- **Preliminary beliefs underpinning this thesis include:** (1) Crypto will be the preferred payment rail for agent-to-human and agent-to-agent commerce, (2) Generative AI and natural-language interfaces will become the primary modality for users seeking to transact onchain, and (3) AI will create the majority of all software code (incl. smart contracts), resulting in a cambrian explosion of onchain apps and experiences.
- The **intersection of Crypto and AI** is composed of two core sub-segments: (1) **Decentralized AI (Crypto -> AI)** defined as building generic AI infrastructure to inherit the properties of modern peer-to-peer blockchain networks and (2) **Onchain AI (AI -> Crypto)** defined as building infrastructure and apps that leverage AI to power both new and existing use cases.
- The **Crypto x AI landscape** can be segmented into the following layers: (1) **Compute** (i.e., networks focused on supplying latent graphics processing units (GPUs) to AI developers), (2) **Data** (i.e., networks that enable decentralized access, orchestration, and verifiability of the AI data pipeline), (3) **Middleware** (i.e., networks/platforms that enable the development, deployment, and hosting of AI

models / agents), and (4) **Applications** (i.e., user-facing products (B2B or B2C) that leverage onchain AI mechanisms)

At Coinbase, we're on a mission to help update the financial system to make it safer and more secure, while improving accessibility and usability for consumers and builders alike. We believe Crypto x AI is going to play a significant role in this. In this blog, we'll dive deeper into the why, how, and what next of Crypto x AI.

An introduction to Crypto x AI

The AI market has seen significant growth and investment, with venture capital firms pouring nearly \$290 billion into the sector over the past five years. The World Economic Forum [suggests](#) that AI technologies could boost annual US GDP growth by 0.5-1.5% over the next decade. AI applications are demonstrating real traction, with apps like ChatGPT4 setting new records for user growth / adoption. However, as the AI market rapidly evolves, several challenges are emerging, including data privacy concerns, the need for AI talent, ethical considerations, centralization risks, and the rise of deepfake technology. These challenges are driving the current discourse around the intersection of crypto and AI, as stakeholders seek solutions that leverage the strengths of both technologies to address these emerging issues.

Crypto x AI combines blockchain's decentralized infrastructure with AI's ability to mimic human cognitive functions and learn from data, creating a synergy that could revolutionize various sectors. Blockchain redefines system architectures, data / transaction verification, and distribution. AI enhances data computation, analysis, and offers new content generation capabilities. This intersection has sparked both excitement and skepticism among developers in both technology communities, driving the exploration of novel use cases that could accelerate the adoption of both sectors in the long term.

While crypto and AI are both general terms that encompass a wide range of different technologies and themes, we believe the intersection of both fields can be broken down into two core sub-segments:

- **Decentralized AI (Crypto -> AI)** enhances AI capabilities through crypto's permissionless, and composable infrastructure. This unlocks use cases such as democratized access to AI resources (e.g., compute, storage, bandwidth, training data, [etc](#)), collaborative, open-source model development, verifiable inference, or immutable ledgers and cryptographic signatures for content provenance and authenticity.
- **Onchain AI (AI -> Crypto)** brings AI's benefits to the crypto ecosystem, improving user and developer experiences via LLMs and natural-language interfaces or enhancing smart contract capabilities. Two pathways for onchain AI adoption include: (1) Developers integrating AI models or agents into their smart contracts and onchain apps and (2) AI agents leveraging crypto rails (e.g., self-custody wallets, stablecoins, [etc](#)) for payments and commissioning decentralized infrastructure resources.

While both segments are still nascent, the potential for "Crypto in AI" or "AI in Crypto" is significant and poised to unlock a new set of use cases that haven't been conceived of, especially as compute infrastructure and

intelligence speeds continue to improve.

Crypto x AI: A key unlock for the “Agentic Web”

One area that we find to be particularly exciting across Crypto and AI is the concept of AI agents operating on crypto infrastructure rails. This integration aims to create the “Agentic Web”, a transformative paradigm that could enhance security, efficiency, and collaboration in AI-driven economies, underpinned by robust incentive structures and cryptographic primitives.

We believe that AI agents can become significant drivers of economic activity / growth and the predominant “users” of applications (both on/offchain), gradually shifting away from human users in the medium-to-long term. This paradigm shift would force many internet-native firms to rethink their core assumptions about the future and deliver the necessary products, services, and business models to best serve a largely agent-based economy.

With that said, **we do not believe crypto / blockchain technology is required to advance capabilities or solve emerging challenges in every layer of the AI tech stack.** Rather, crypto can play a major role in bringing more distribution, verifiability, censorship-resistance, and native payment rails to AI, while benefiting from AI mechanisms to power new user experiences onchain.

Our preliminary beliefs underpinning this thesis are as follows:

- **Crypto will be the preferred payment rail for agent-to-human and agent-to-agent commerce:** Crypto is internet-native, programmable money that has several advantages for powering the agent-based economy. As AI agents become more autonomous and engage in micro-transactions at scale (e.g., paying for inference, data, API access, decentralized compute or data resources, [etc](#)), crypto's efficiency, borderless nature, and programmability will make it the preferred medium of exchange over traditional fiat rails. Additionally, agents will require unique, verifiable identities (i.e., "[Know Your Agent](#)") to ensure adherence to regulatory rules and compliance requirements while transacting with enterprises and end-users. Low-fee blockchains, smart contracts, self-custody wallets (e.g., [Coinbase AI Wallets](#)), and stablecoins can help streamline and reduce costs for complex financial agreements between agents, while the verifiability and immutability of decentralized networks will ensure the trust and auditability of AI agent transactions.
- **Generative AI and natural-language interfaces will become the primary modality for users seeking to transact onchain:** As natural language processing speed and AI's contextual understanding of crypto improves, interacting onchain through conversational interfaces will become the default

user norm and expectation, in line with current web2 trends (e.g., ChatGPT). Users will simply describe their desired transaction intent in natural language (e.g., “Swap X for Y”), and AI agents will translate those intents into verifiable smart contract code, offering the most efficient and cost-effective transaction execution path.

- **AI will create the majority of all software code (incl. smart contracts), resulting in a cambrian explosion of onchain apps and experiences:** AI's code generation capabilities are rapidly advancing in web2 (e.g., [Devin](#), [Replit](#)), and fundamentally changing software development paradigms. We believe this shift will soon take center stage in crypto, with a [near](#) term focus on significantly lowering the barrier of entry for new and existing builders. However, the future state consists of AI “software agents” generating smart contracts and hyper-personalized apps from scratch in real-time, based on a user's preferences, stored and verified onchain.

These beliefs suggest a future where the lines between AI and crypto become increasingly blurred, creating a new paradigm of intelligent, autonomous, and decentralized systems. With this framing in mind, let's take a closer look at the enabling Crypto x AI tech stack layer-by-layer.

Opportunities within the Crypto x AI Stack (Today)

The quest to integrate “Crypto into AI” or “AI into crypto” has given rise to a burgeoning, yet complex, landscape that is rapidly evolving, with many builders rushing to capitalize on market momentum. Today, we believe the Crypto x AI landscape can be segmented into the following layers: (1) **Compute** (i.e., networks focused on supplying latent graphics processing units (GPUs) to AI developers), (2) **Data** (i.e., networks that enable decentralized access, orchestration, and verifiability of the AI data pipeline), (3) **Middleware** (i.e., networks/platforms that enable the development, deployment, and hosting of

AI models / agents), and (4) **Applications** (i.e., user-facing products (B2B or B2C) that leverage onchain AI mechanisms)

Compute

AI necessitates vast computational GPU resources for both the training of models and execution of inferences. Given that AI models are becoming increasingly complex and growing in their demand for compute, there is a scarcity of state-of-the-art GPUs, such as Nvidia's offerings, resulting in long wait times and increasing costs. Decentralized compute networks are emerging as a potential solution to those challenges by:

- Establishing permissionless marketplaces for buying, renting, and hosting physical GPUs
- Building GPU aggregators that enable anyone (e.g., [Bitcoin](#) miners) to contribute their excess GPU compute capacity for on-demand AI job execution, in return for token incentives
- Financializing physical GPUs by tokenizing them into digital assets onchain
- Developing distributed GPU networks for computationally intensive workloads (e.g., training, inference)
- Creating infrastructure that enables AI models to be

run on personal devices (think decentralized Apple Intelligence)

Each of these proposed solutions aim to increase GPU compute supply and accessibility, while offering very competitive pricing. However, given that most players in this segment have varying degrees of support for advanced AI workloads, face challenges related to the lack of co-location of GPUs, and in some cases, lack developer tooling and uptime guarantees on par with centralized alternatives, we believe that mainstream adoption of these offerings is unlikely in the near-to-medium term. Emerging segments and sample projects building at this layer include the following:

- **General-purpose Compute:** Decentralized compute marketplaces that provide GPU computing resources that can be used for a variety of applications (e.g., [Akash](#), [Aethir](#))
- **AI / ML Compute:** Decentralized compute networks that provide GPU computing resources for a specific service, such as GPU aggregators, distributed training and inference, GPU tokenization, etc (e.g., [io.net](#), [Gensyn](#), [Prime Intellect](#), [Hyperbolic](#))
- **Edge Compute:** Compute and storage networks that power on-device LLMs for personal, contextualized inference (e.g., [PIN AI](#), [Exo](#), [Flock.io](#))

Scaling AI models requires growing training datasets, with LLMs being trained on trillions of words from human-generated text. However, there is only a finite amount of public, human-generated data today ([Epoch AI estimates high quality language / data sources could be exhausted by 2024](#)), which raises the question of whether the lack of training data could become a major bottleneck, potentially leading to a plateau in AI model performance. Therefore, we believe data-focused, crypto x AI firms have the following opportunities to address these challenges:

- Incentivize users to share their private / proprietary data (e.g., “[Data DAOs](#)” - onchain entities where data contributors could see economic upside from contributing their private data from social platforms govern how that data is used and monetized)
- Create tooling for generating synthetic data assets from natural language prompts or provide user incentives to scrape data from public websites
- Incentivize users to help pre-process datasets for training models and maintain data quality (e.g., data labeling / reinforcement learning from human feedback)
- Establish multi-sided, permissionless data markets, where anyone can be compensated for contributing.

These opportunities are giving rise to many of the emerging players we see in the data layer today. However, it's worth noting that centralized incumbents across the AI model lifecycle have existing network effects and proven data compliance regimes that traditional enterprises value, which may leave little room for decentralized alternatives. With that said, we believe the data layer for decentralized AI presents a significant long-term opportunity to address the “Data Wall” challenge. Emerging segments and sample projects building at this layer include the following:

- **Data Marketplaces:** Decentralized data exchange

protocols designed for data providers and consumers to share and trade data assets (e.g., [Ocean Protocol](#), [Masa](#), [Sahara AI](#))

- **User-owned / Private Data (incl. DataDAOs):** Networks designed for incentivizing the collection of proprietary datasets, including private user-owned data (e.g., [Vana](#)*, [NVG8](#))
- **Public & Synthetic Data:** Networks / platforms for scraping data from public websites or generating new datasets via natural language prompts (e.g., [Dria](#), [Mizu](#), [Grass](#), [Synesis One](#))
- **Data Intelligence Tools:** Platforms and applications designed to query, analyze, visualize, and provide actionable insights on onchain data (e.g., [Nansen](#)*, [Dune](#)*, [Arkham](#), [Messari](#)*)
- **Data Storage:** File storage networks intended for long-term data storage / archiving and relational database networks designed for managing structured data that is accessed and updated frequently (e.g., [Filecoin](#), [Arweave](#)*, [Ceramic](#)*, [Tableland](#)*)
- **Data Orchestration / Provenance:** Networks and platforms that optimize data ingestion pipelines and processing for AI and data-intensive applications and ensure proper provenance tracking and verifiable authenticity of AI-generated content (e.g., [Space and Time](#), [The Graph](#)*, [Story Protocol](#))

- **Data Labeling:** Networks and platforms that improve reinforcement learning and fine-tuning mechanisms for AI models by incentivizing a distributed network of human contributors to create high-quality training datasets (e.g., [Sapien](#), [Kiva AI](#), [Fraction.AI](#))
- **Oracles:** Networks that use AI to provide verifiable offchain data for onchain smart contract (e.g., [Ora](#), [OpenLayer](#), [Chainlink](#))

Middleware

Realizing the full potential of an open, decentralized AI model or agent-based ecosystem requires new infrastructure to be constructed. Some high-potential areas that builders are exploring include the following:

- Employing the use of open-weight LLMs to power onchain AI use cases while simultaneously building foundational models that can quickly understand, process, and act on onchain data
- Distributed training solutions for large foundational models (e.g., 100B+ parameters); often seen as a pipe dream due to various technical complexities, but recent breakthroughs by [Nous Research](#), [Bittensor](#), and [Prime Intellect](#) are seeking to change that narrative
- Leveraging zero-knowledge or optimistic machine learning (i.e., zkML, opML), trusted execution environments (TEEs), or fully-homomorphic encryption (FHE) to enable private, and verifiable inference
- Enabling open, collaborative AI model development via resource coordination networks or building agentic networks/platforms that leverage crypto infra rails to enhance AI agent potential for on/offchain use cases

While there has been some progress on building these fundamental infrastructure primitives, production-ready,

onchain LLMs and AI agents are still nascent, and we don't expect this dynamic to change in the [near](#)-to-medium term, subject to the underlying compute, data, and model infra maturing. With that said, we see this category as being very promising and a core focus for Coinbase Ventures' investment strategy in the space, driven by the implied growth and demand for AI services long-term. Emerging segments and sample projects building at this layer include the following:

- **Open-weight LLMs:** AI models whose weights are publicly accessible, allowing anyone to use, modify, and distribute them freely (e.g., [LLama3](#), [Mistral](#), [Stability AI](#))
- **Onchain Model Creators:** Networks and platforms enabling the creation of foundational LLMs for onchain use cases (e.g., [Pond](#)*, [Nous](#), [RPS](#))
- **Training & Fine-tuning:** Networks and platforms that enable incentivized and verifiable training or fine-tuning mechanisms onchain (e.g., [Gensyn](#), [Prime Intellect](#), [Macrocosmos](#))
- **Privacy:** Networks and platforms that employ privacy-preserving mechanisms for the development, training, and inference of AI models (e.g., [Bagel Network](#), [Flock](#), [ZAMA](#))
- **Inference Networks:** Networks that employ cryptographic techniques / proofs to verify the

correctness of AI model outputs (e.g.,
[OpenGradient*](#), [Modulus Labs](#), [Giza](#), [Ritual](#))

- **Resource Coordination Networks:** Networks designed to facilitate the resource sharing, collaboration, and coordination of AI model development (e.g., [Bittensor](#), [Near*](#), [Allora](#), [Sentient](#))
- **Agentic Networks & Platforms:** Networks and platforms that facilitate the creation, deployment, and monetization of AI agents for both on/offchain environments (e.g., [Morpheus](#), [Olas](#), [Wayfinder](#), [Payman*](#), [Skyfire*](#))

Applications

Within crypto, AI agents are beginning to make their presence felt, with early instances like [Dawn Wallet](#) (i.e., a crypto wallet that utilizes AI agents to send transactions and interact with protocols on behalf of users), [Parallel Colony](#) (i.e., an onchain game where players partner with AI agents that have their own wallets and can create their own pathways within the game), or [Venice.ai](#) (i.e., a generative AI app / natural language prompt with verifiable inference and privacy-preservation mechanisms). However, app development is still largely experimental and opportunistic, with a disarray of app ideas blooming

from [hype](#) in the space. With that said, we believe advancements in AI agent infrastructure and frameworks are poised to shift the crypto design space from primarily reactive smart contract applications to more complex, proactive applications in the medium-to-long term. Emerging segments and sample projects building at this layer include the following:

- **AI Companions:** Apps for creating, sharing, and monetizing user-owned AI models and agents with personalized and contextual awareness (e.g., [MagnetAI](#), [MyShell](#), [Deva](#), [Virtuals Protocol](#))
- **NLP-based Interfaces:** Apps in which natural language prompts are the primary interface / entry point for interacting with and executing onchain transactions (e.g., [Venice.AI](#), [Veldt](#))
- **Dev / Security Tools:** Developer-facing apps/tools that leverage AI models / agents to enhance onchain developer experiences and security mechanisms (e.g., [ChainGPT](#), [Guardrail](#)*)
- **Risk Agents:** Services that leverage ML models or AI agents to help protocols dynamically adjust and respond to onchain risk parameters in real-time (e.g., [Chaos Labs](#)*, [Gauntlet](#)*)
- **Identity (Proof of Personhood):** Apps that leverage cryptographic proofs and ML models to verify user's proof of personhood. (e.g., [Worldcoin](#)*)

- **Governance:** Apps that leverage AI agents to execute transactions based on human-driven governance decisions / feedback (e.g., [Botto](#), [Hats](#))
- **Trading / DeFi:** AI-powered trading infrastructure and DeFi protocols that utilize AI agents to automate onchain transaction execution (e.g., [Taoshi](#), [Intent.Trade](#))
- **Gaming:** Onchain games that utilize intelligent NPCs or AI mechanisms to power core gameplay mechanics (e.g., [Parallel](#), [PlayAI](#))
- **Social:** Apps that utilize AI mechanisms to power onchain social experiences (e.g., [KaiKai](#), [NFPrompt](#))

Conclusion

While the Crypto x AI stack is still in its nascent stages, we believe there will be significant advancements in decentralized AI infrastructure, onchain AI applications, and the emergence of an "Agentic Web" where AI agents become the primary drivers of economic activity. While challenges remain in areas such as compute infrastructure and data availability, the synergies between crypto and AI could accelerate innovation in both sectors, leading to more transparent, decentralized, and autonomous systems. As the landscape continues to rapidly evolve, driven by new teams securing funding and more established teams working towards finding product/market fit, it will be crucial for internet-native

firms and developers to adapt to the changing paradigm and embrace the potential for Crypto x AI to create novel applications and experiences that were previously unimaginable.

Overall, Coinbase Ventures is excited about the future potential and opportunities within Crypto x AI, and we are actively investing within each layer of the stack. If you're building edge computing infrastructure, decentralized data collection / provenance networks, agentic networks or platforms employing onchain payment rails, or novel applications powered by onchain AI mechanisms, we would love to hear from you.

Related work

- Coinbase Developer Documentation: [AI Wallets](#), September 2024
- Coinbase Research: [Blockchain for AI](#), March 2024