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TenSquared Research

Web3 and Artificial Intelligence: The State of Play

FEBRUARY 2024

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Special thanks to John Peurifoy and Hardik Mittal for review and feedback.

TenSquared is a growth equity firm focused on Inflection Point Investing where Digital Asset Ecosystem (DAE) companies transform into future technology leaders.

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IMPORTANT DISCLOSURES

Executive Summary

- AI is dominating the narrative as one of the most promising trends of 2024.
- Goldman Sachs estimates that AI adoption could drive almost $7T in global economic growth over ten years, with productivity growing 1.5% faster annually over the same period.[1] AI is recognized as the next significant technological shift after the evolution of the internet, mobile, and the cloud.
- AI and blockchain technologies could build on each other and compound over time:
  - Blockchain can act as a source of reliable data for AI, enhancing the trust and privacy of data without intermediaries. It can also facilitate the decentralization of compute power and storage across companies and geographies and provide alternatives to the big tech monopolies.
  - In turn, AI has the potential to revolutionize decentralized networks and applications and drive massive adoption of Web3 technologies. AI can enable smart contracts to make decisions based on dynamic on-chain data, creating new functionalities.
  - When AI and blockchain are combined, they can lead to major industry data and information security advances, like zero-knowledge machine learning (ZKML) based solutions.
  - Still, blockchain and AI technologies are currently at different levels of adoption. The challenges to adopting blockchain+AI are mainly scalability, compatibility, and governance issues. Blockchain networks are still being developed and may not be able to process with speed the high volume and complexity of data that AI systems require. As the technologies advance, blockchain+AI could complement and elevate each other, resulting in a more diverse and enriched technological landscape.
- The research and development activity in the blockchain+AI field has been consistently rising over the last five years and resulted in 6.9k blockchain+AI -related GitHub repositories and 539k GitHub pull requests, 1.5k filed patents, and 5.6k research publications as of December 31, 2023.[2]
- The market sentiment has been optimistic about the growth potential of AI on-chain. The market capitalization of the top 15 AI-related tokens reached $12Bn in 2023 and showed an impressive growth of 443% in 2023 compared to 108% for the total crypto market capitalization.[3]
- There is a wave of new startups working at the intersection of blockchain+AI and developing code writing tools, decentralized data storage, compute infrastructure for AI, content authenticity, privacy, and AI-enabled Web3 security solutions. The VC funding of the blockchain+AI startups exceeded $0.6Bn in 2023.[4]
- Besides driving the formation of new startups, AI technology could significantly affect existing digital asset companies by helping them to optimize expenses, increase revenues, and build moats.
- At TenSquared, we look for great companies that have demonstrated product-market fit and are addressing real pain points at the intersection of blockchain and AI. We are looking beyond the hype to find ways that these technologies can transform the future of businesses and our lives and have exponential outcomes.

1) - Goldman Sachs, Generative AI - Part I: Laying Out the Investment Framework

2) - GitHub, World Intellectual Property Organization, Dimensions.ai

3) - CoinGecko, as of December 31, 2023

4) - Pitchbook

I. Why AI Needs Blockchain: Blockchain-based Solutions for AI

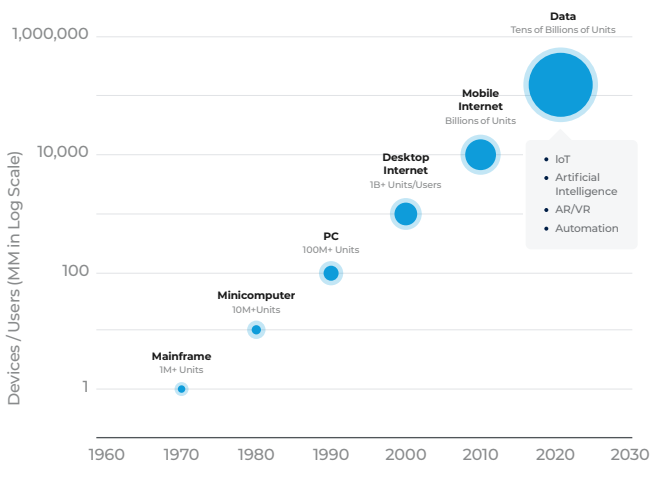
There are a few areas where blockchain technology can provide viable solutions to fundamental problems of AI:

- Blockchain solves the trust problem for AI data. It can provide an essential framework to anchor content's authenticity on-chain and build incentives to collect and share real-world data.
- Blockchain could reduce the centralization risk of AI by facilitating the decentralization of AI infrastructure, including: data storage, data set creation, and compute power.
- Blockchain-based solutions could improve data privacy in AI by creating decentralized identities and offering more secure and efficient cybersecurity systems.

Blockchain Solves the Fundamental Trust Problem for AI Data

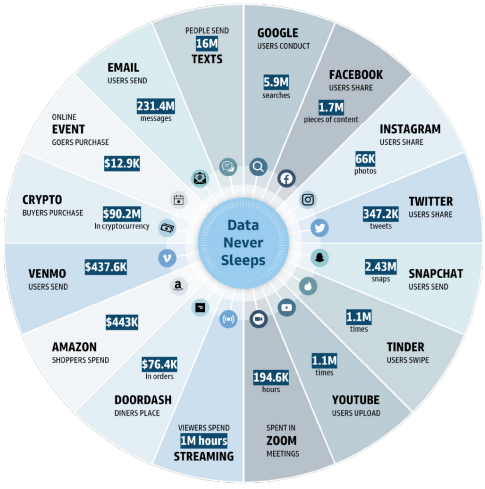
- AI is one of the fastest-growing technologies of our time, transforming businesses. The enterprise adoption of AI has been and will continue to take place at a staggering pace.
- Big Data has been key in accelerating the growth of AI. It is the proliferation of data that has enabled the training of AI to be smarter and more efficient:
  - AI systems integrate, synthesize, and interpret our data, unlocking knowledge.
  - AI accelerates software system development, making companies more productive and efficient by automating decision-making and recurring tasks and reducing human errors.
  - Interaction with AI software and information becomes as easy as typing or speaking, which leads to broader adoption and more data produced. Thus, the pace of data creation and progress increases exponentially.

Computing Growth Drivers Over Time, 1960-2030E



Source: Morgan Stanley, Investors, "Get ready for the data decade"

Amount of Data Generated Per Minute Of The Day



Source: Domo, Data compiled by Goldman Sachs Investment Research

- However, there is a fundamental trust problem for AI: it becomes difficult to tell what data is real and what is fake.
- As AI capabilities continue to evolve, proving content authenticity becomes a priority. Generative AI has the potential to create a flood of misinformation and deepfakes as the cost of content creation falls.

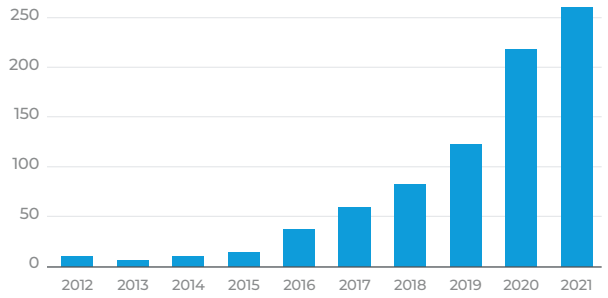
FUNDAMENTAL TRUST PROBLEM FOR AI

- There has been a **10x increase** in the number of AI-powered fraud (mainly deepfakes) detected globally across all industries from 2022 to 2023.[1]
- In 2022, **66%** of cybersecurity professionals experienced deepfake content attacks within their organizations.[2]
- Researchers predict that as much as **90%** of online content may be synthetically generated by 2026.[3]

Unalterable digital histories, such as blockchain records and digital signatures, become the ground truth for everything digital.

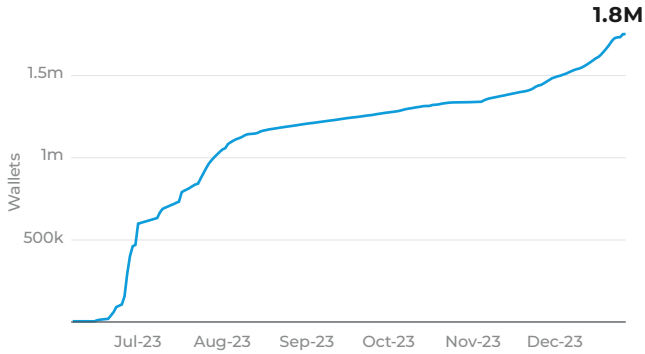
- Blockchain provides an essential framework to anchor the authenticity and provenance of content on-chain:
  - **Cryptographic digital signatures** can verify content creators by validating the signature through a corresponding public key. Digital signatures use encryption and public-key cryptography to sign and verify digital content.
  - **Establishing a verifiable provenance record** can also be used to differentiate between original and manipulated data. For example, Bundlr and Arweave are developing a standard known as the Digital Content Provenance Record. This standard will ensure that authentic digital content and data include an immutable cryptographic signature provided by the content creator and a cryptographic timestamp recorded on-chain. In January 2024, Fox Corp and Polygon released a blockchain-powered tool, "Verify", to fight AI-generated media stories or deepfakes.
  - Worldcoin is creating **a digital identification system called World ID**. World ID aims to verify the authenticity of online content or interaction through the blockchain. It represents a potential solution for the proliferation of bots and deepfakes. As of November 2023, Worldcoin had 1M+ active users and 4M+ downloads from dozens of countries.

Number of AI Incidents and Controversies, 2012-2021



Source: AIAAIC, 2012-2021, 2023 AI Index Report, Stanford University Human-Centered Artificial Intelligence

WorldApp Wallets Over Time



Source: Worldcoin

Blockchain technology is a key solution to verifying content authenticity.

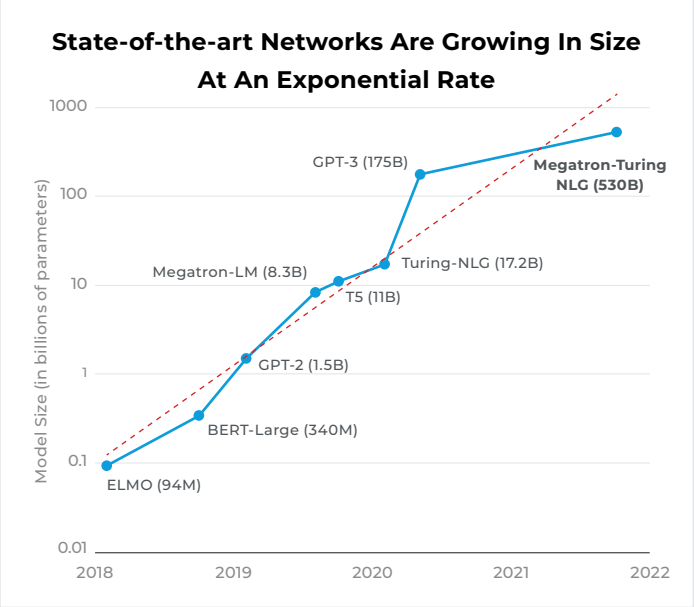
1) - Sumsub Identity Fraud Report 2023

2) - https://www.weforum.org/agenda/2023/05/how-can-we-combat-the-worrying-rise-in-deepfake-content/

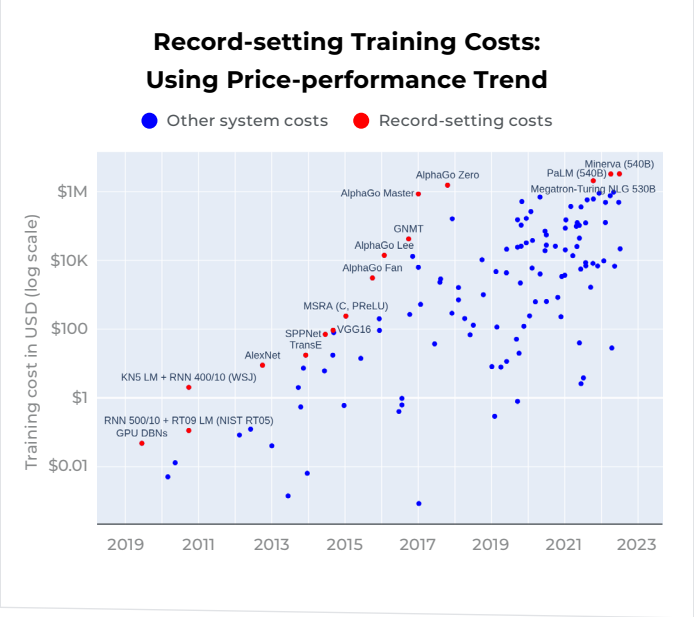
3) - https://www.europol.europa.eu/cms/sites/default/files/documents/Europol_Innovation_Lab_Facing_Reality_Law_Enforcement_And_The_Challenge_Of_Deepfakes.pdf

Blockchain Could Reduce the Centralization Risk of AI

- AI augments the market centralization risk, where the large technology companies with the most data, compute infrastructure, capital and distribution capabilities (such as Microsoft, Google, Amazon) can generate significant advantages.
- **Centralization risk of the Large Language Model (LLM) market:** There is a significant risk that AI's capital-intensive nature could concentrate power among a few players owning massive data facilities. A few winners in the AI market could charge prohibitive fees or make it hard for users and developers to switch to other providers.
- **Global GPU shortage:** Increased demand for training ML models, model complexity (size), and computation requirements have caused a global Graphics Processing Units (GPU) shortage and a corresponding price hike for NVIDIA GPUs.[1] While the cost of training AI models can be significant, it is nothing compared to the expenses incurred from handling daily user inferences (queries).
  - The training of OpenAI's GPT-3 required 1,000 NVIDIA V100 GPUs, amounting to $12M.[2] OpenAI's estimated daily expenditure for model inference is approximately $700,000.[3] GPT-3.5 employs 8 NVIDIA A100s per user interface, and it's speculated that GPT-4 requires as many as 80 A100s per interface.[4]
  - Model training alone could hit 1% of US GDP in the next eight years.[5]



Source: Nature.com, Gensyn



Source: Epoch AI, This graph depicts the increasing costs of training machine learning ("ML") models. The high costs of such models empowers incumbents to the detriment of builders.

- Blockchain can facilitate the decentralization of AI infrastructure across companies and geographies and provide alternatives to the big tech monopolies.
- Decentralized AI infrastructure players align their platform incentives with their users through crypto tokens. They can ensure lower costs for developers to train their models and enable compute providers to monetize their idle compute resources, which is particularly relevant given the global GPU shortage.
- AI decentralized infrastructure examples include decentralized storage, compute power, machine learning, and data set creation.

> Decentralized AI infrastructure providers not only fight the centralization risk, but also lower barriers to entry for smaller players, facilitating market competition and AI innovation.

Sources:

1) - In general, model complexity (size) of the best neural networks is currently doubling every three months., Nature.com, Gensyn

2) - https://venturebeat.com/ai/openai-launches-an-api-to-commercialize-its-research/

3) - The Information, SemiAnalysis Research

4) - https://twitter.com/SullyOmarr/status/1651275491448438822

5) - Epoch AI, Gensyn

Decentralized Storage

- As changes in AI models can be recorded and used for learning new data, decentralized data storage becomes particularly important. Companies such as Filecoin and Arweave have been playing an increasing role in the digital asset ecosystem. Their competitive advantages are decentralization, data privacy, security, incentive mechanisms, and competitive pricing, though retrieval times and speed are still a big issue and a major tradeoff of decentralization.
  - The cost of decentralized file storage on blockchains such as Filecoin, Arweave, Swarm, StorJ, and Sia currently ranges from near zero to $4 per terabyte (TB) per month, according to Foresight Ventures. This is lower than the cost of traditional Web2 services such as Amazon Cloud or Microsoft Azure, where prices can range from $16 to $23 per TB of monthly storage.[1] However, such considerations as the quality of service, service-level agreements, and other competitive advantages often outweigh cost considerations for most customers. So far, the main customers for decentralized storage networks have been other crypto networks.

Decentralized Compute Networks

- Decentralized compute networks can act as AI model repositories, like Hugging Face (a centralized repository) for traditional AI, but also provide advantages of blockchain, like decentralization, data privacy and security, and incentive mechanisms for participants. They are also often called decentralized AI marketplaces.
  - For example, the Akash Network is an open-source Supercloud that allows users to securely and efficiently buy and sell computing resources. It enables users to own their cloud infrastructure, deploy applications, and rent unused cloud resources. Akash operates as a decentralized public utility, utilizing a "reverse auction" system that often offers up to 85% lower prices than other cloud systems.[2] The network is owned and managed by its community and built on resilient technologies like Kubernetes and Cosmos.
  - Another example is Gensyn, which provides a decentralized marketplace where anyone can monetize spare GPU capacity for collective model training. This machine learning (ML) protocol rewards providers of idle compute capacity for pledging their compute time to the network and performing ML tasks while allowing developers to run AI algorithms on smaller data centers and other connected hardware and to pay on demand. Gensyn uses a novel cryptographic verification system that, without the need for intermediaries, allows users to determine that machine learning work shared over the protocol has been finished correctly.[3]
  - The rise of AI drives demand for GPU graphics. The Render Network is a leading distributed rendering platform built by utilizing blockchain technology to aggregate idle GPUs worldwide and to provide a platform for creating images, videos, and other content. Compared with centralized cloud rendering services, Render Network has nearly unlimited computing power resources and features high computational efficiency, low cost, and good security. In the first half of 2023, Render Network successfully processed over 4.6 million frames, providing a cost-effective solution compared to other rendering farms, with an average subscription cost of $20 per month.[4]

General-purpose compute networks

- **General-purpose (GP) compute networks** operate like decentralized clouds, providing computing resources for various applications, including any machine learning workload.

akash · iExec · RNDR · Flux · truebit · CUDOS · exaBITS · Bacalhau

Special-purpose compute networks

- **Special-purpose (SP) compute networks** are tailored to specific use cases:
  - *Model training* – models are trained on large datasets to learn the patterns and relationships within the data.
  - *Fine-tuning* – ML models can be further optimized using a smaller dataset to improve performance for a specific task.

gensyn · together.ai

  - *Model inference* – the trained and fine-tuned models are run to make predictions in response to user queries.

Giza · ModulusLabs · bittensor · rendernetwork · ChainML

1) - https://cointelegraph.com/news/decentralized-file-storage-pricing-differentials-persist-despite-market-growth-report
2) - https://www.akash.network
3) - https://www.coindesk.com/business/2023/06/11/blockchain-based-ai-compute-protocol-gensyn-closes-43m-series-a-funding-round-led-by-a16z/
4) - the Render network

- Although sourcing the most performant GPUs (A100s and H100s) might be challenging, decentralized GPU networks could aggregate more accessible consumer-grade GPUs and create a valuable resource pool for ML developers.
- Decentralized compute networks are represented by general-purpose networks, operating like a decentralized cloud (e.g., Akash), and special-purpose decentralized compute networks, solving for specific use cases: model, fine-tuning or inference (e.g., Gensyn, Gyza, Modulus Labs, ChainML).
- There has been a surge in special-purpose compute networks focused on inference capabilities recently. Estimates from Amazon and NVIDIA suggest that inference tasks account for 80% or more of AI computational demand. Inference tasks and fine-tuning have lesser computational and bandwidth needs and seem more technically feasible on distributed networks in the short term than model training tasks.[1]
- While general-purpose compute networks offer greater functionality, special-purpose compute networks are expected to gain adoption quicker in the short term as a network's UX and performance can be more easily optimized for specific use cases.

> Decentralized compute networks provide accessible and cost-effective alternatives and computational liberty for everyone.

Decentralized Data Set Creation

- **Decentralized networks can incentivize data set creation** by allowing individuals and smaller companies to derive financial value from data set creation and sharing.
  - Bittensor is one of the examples of such collaborative networks that incentivize knowledge production by rewarding participants for exchanging knowledge through their unique ML models. Bittensor's blockchain is built using the Substrate framework, which is a modular framework that enables the creation of purpose-built blockchains. These purpose-built blockchains function through Bittensor's network, which allows them to interact and join into a singular computing infrastructure.
  - Bagel Network is building a decentralized data platform where data providers can post ZK commitments to the on-chain marketplace, which will verify the integrity of the initial data set and track changes, similar to how GitHub works. The quality of the data sets will be determined by a combination of the free market and Bagel Network's reputation mechanisms, backed by staked tokens.[2]
- **Reinforcement learning from human feedback (RLHF)** is a technique that incorporates human feedback in the training process to fine-tune a model. The need for such experts to provide feedback grows as the demand for domain-specific models increases. Token-incentivized RLHF decentralized networks can be used to fine-tune models and reduce inaccurate or biased outputs.
- **Decentralized physical infrastructure networks (DePINs)** incentivize individuals to gather real-world data, typically through sensors, or pay people bounties to participate. Historically, there has been an issue about where the data gets input and how trustworthy it is. DePINs offer a valuable means of collecting real-world data that can be utilized for model-training purposes.
  - Examples of companies operating in the DePIN space include Helium (a decentralized wireless IoT network), Dimo (a user-owned connected vehicle platform), and Hivemapper (a crowdsourced map built on data from vehicle dashcams).
  - In December, Peaq, the blockchain for real-world applications, Robert Bosch GmbH, the world's largest sensor manufacturer, and Fetch.ai, a Web3 AI company that provides infrastructure for smart, autonomous services, announced a new smart sensor, the Bosch XDK110 Rapid Prototyping Kit, which enables anyone to tap advanced Web3 and AI tech to earn rewards in crypto.

> Blockchain incentivizes collaborative data set creation and training of models on decentralized networks, which increases training efficiency.

1) - https://arxiv.org/pdf/2205.09646.pdf
2) - the Block

Blockchain-based Solutions Improve Data Privacy In AI

- One of the key challenges for AI is that it can be used to violate privacy. AI systems require large amounts of data, which can be used for identity theft or cyberbullying.

> Forbes
>
> *"Americans Are Terrified About AI:*
> ***80%** Say AI Will Help Criminals Scam Them"*
>
> – Forbes, August 2023[1]

- **80%** are concerned that their personal data is being used to train AI models.
- **77%** are afraid AI tools will deepfake their voices or faces to commit fraud.
- **80%** say AI has increased the likelihood that their personal data will be used in malicious ways by criminals or hacker collectives.
- **70%** are worried that AI will be used by other nations in information warfare campaigns.

- Blockchain can be used to build encrypted networks. Combining AI and blockchain could enable more secure and efficient cybersecurity systems.
- **One of the solutions is self-sovereign identity** when individuals have control over their identities and have autonomy to decide what information about their identity they want to share. Decentralized identity is a self-sovereign identity on-chain that enables the privacy and security of personal data.
  - Some of the blockchain companies working on decentralized identity include WorldCoin, Spruce ID (developer of digital identity software), and Clique (an identity oracle connecting Web2 and Web3).
- **Zero-knowledge (ZK) proofs** enable easy access to identity and other data while maintaining privacy and property control. A ZK proof is a cryptographic protocol in which one party, the prover, can prove to another party, the verifier, that a given statement is true, without revealing any additional information beyond the fact that the statement is true. ZK proofs are widely used to scale Ethereum with ZK rollups, build privacy-preserving applications, and identify primitives.
  - Some of the companies working here include Aztec (a hybrid ZK rollup-based solution and encrypted apps), Semaphore (a generic, open-source privacy layer for Ethereum applications based on ZK-SNARKs), Sismo (a sovereign identity aggregator and crypto native single sign-on (SSO)).
- **Homomorphic encryption** enables complex computations on encrypted data without first having to decrypt it. It is particularly useful for sensitive data, such as health care information.
  - Fhenix Protocol is the first confidential blockchain powered by fully homomorphic encryption. Zama is a cryptography company building open-source homomorphic encryption solutions for blockchain and AI.
- Other encryption solutions used for decentralized networks include secured multi-party computations (MPC) and GAN cryptography.

ZKML – Privacy-preserving Verification For AI

- ZKMLs (zero-knowledge machine learning) is a new use case of blockchain for AI. ZKML enables secure and privacy-preserving verification of machine learning models, improving trust and transparency in AI-based DApps and smart contracts.
- ZK proofs, and more specifically SNARKs, are most useful for the verification of correct computation of machine learning on-chain. ZKSNARKs allow smart contracts to trustlessly query machine learning models and thus prove machine learning inference (prediction results).[2]
- According to Aligned.co, the zero-knowledge proving market is projected to reach $75M in revenue in 2024, and has the potential to exceed $10Bn in revenue by 2030.[3] ZK proofs will use 25% of the Ethereum block space in 2024 as the industry ramps up, growing to 90% by 2030. Web3 applications will require almost 90Bn ZK proofs in 2030, and Aligned.co expects the average market clearing price per proof to fall from $0.21 in 2024 to $0.12 by 2030.

1) - Source: https://www.forbes.com/sites/johnkoetsier/2023/08/22/americans-are-terrified-about-data-and-ai/

Note: The survey, which asked 1,002 American residents their opinions about AI and privacy, was conducted by an independent market research organization, Propeller Insights.

2) - Zero-Knowledge Succinct Non-Interactive Argument of Knowledge

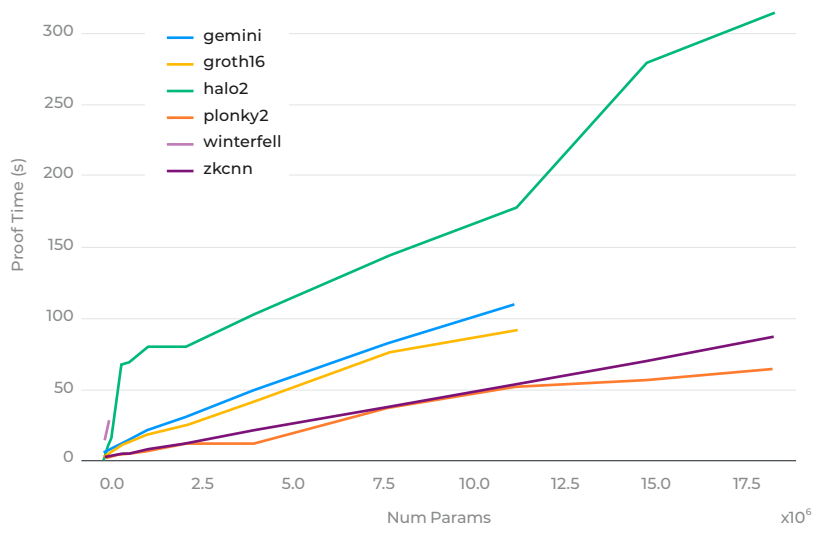
3) - https://aligned.co/blog/10-billion-revenue-market-size-by-2030

ZKML: Use Cases

- **Privacy-preserving model evaluation:** ZKML can be utilized to demonstrate a machine learning model's accuracy without revealing its parameters, allowing users to verify the model's performance on a randomly chosen test set before purchasing it.
- **Computational Integrity (validity ML):** ZKML (SNARKs/STARKs) can be used to prove that computation has happened correctly. ZKML can also verify that the output is the product of a given model and input pair, allowing ML models to be run off-chain and save on on-chain costs.[1]
  - Modulus Labs is building trustless AI with ZKML proofs to make the technology more accessible for crypto protocols.
  - Giza is helping Yearn (a DeFi yield aggregator protocol) to prove that some complex yield strategies that use ML are being correctly executed on-chain.[1]
- **Machine Learning as a Service (MLaaS) transparency:** ZKML can be utilized to prove that a service provider is providing the model they say they are providing.
- **Auditing and fraud detection:** ZKML can be used for conducting audits without revealing sensitive data. Auditors could verify the accuracy and compliance of machine learning models without accessing the raw data, as well as smart contracts where ZK proofs could guarantee a contract fits certain predetermined criteria.

- It is still too early for the current ZK systems to be able to prove current large language models (LLMs), but there has been some success in proving smaller models. According to the study by Modulus Labs "Cost of Intelligence," it is possible to create proofs for models with approx. 18 million parameters in about 50 seconds using a proving system like Polygon's plonky (chart).
- Another issue with ZK proving is its high cost, as it can be significantly more expensive to use ZK proving for inferencing a model than just using AWS. As unit economics becomes increasingly important for on-chain services, service providers must balance the value of on-chain security with the cost of proof generation.[2]
- There is also a question of the importance of 'technological' proof vs. just 'authority' proof; for example, do we always need a way to verify technologically that the computation is true/accurate? Similarly, how much are corporations willing to trust each other's stamp versus needing some technological proof?

Results of a benchmarking study by Modulus Labs of existing ZK proof systems against ML models of different sizes



Source: "The Cost of Intelligence: Proving Machine Learning Inference with Zero-Knowledge." Modulus Labs. Fig. 2, pp. 12. January 20, 2023.

ZKML is a new and fast-growing technology at the intersection of AI and blockchain. Its main use cases include privacy, fraud detection, and verification of computational integrity.

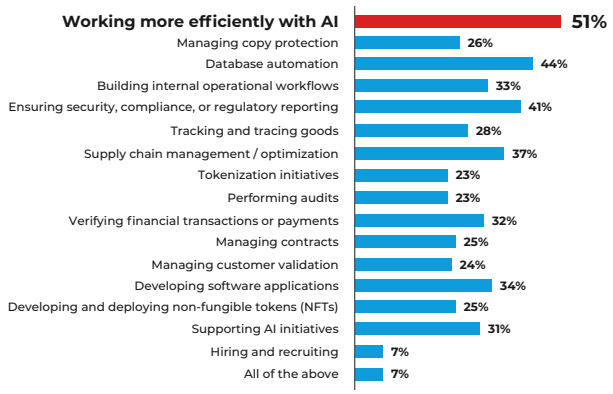
1) - https://worldcoin.org/blog/engineering/intro-to-zkml

2) - Modulus Labs

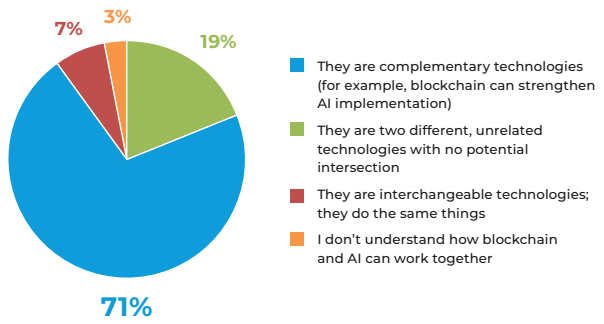
Businesses Overwhelmingly View Blockchain And AI As Complementary Technologies

- According to a recent Casper Labs survey, a growing number of organizations are using blockchain to ensure their AI systems are operating more efficiently and securely.
- The compound benefits of blockchain+AI demonstrate that they are, in fact, complementary solutions that reinforce one another.

Which of the following best describes how your organization uses blockchain technology today?



How does your organization view the intersection of AI technology and blockchain technology?



Casper Labs, Survey: Blockchain Meets AI: Exploring the Challenges and Opportunities of Integration, November 2023. Casper Labs commissioned Zogby Analytics to conduct an online survey of 608 IT decision-makers in six countries: the US, the UK, China, Germany, Austria, and Switzerland.

Growing Interest From Web2 To Web3 AI Projects

> The growing number of partnerships between Web2 and Web3 AI companies reflects the emerging interest in decentralized solutions in the AI domain.

	Crypto Projects	Category	Partnership	
Singularity Net	SingularityNET (AGIX)	AI Marketplace	▪ Cisco	September 2019
fetch.ai	Fetch.ai (FET)	AI Marketplace	▪ Bosch via Fetch Foundation	February 2023
ocean	Ocean Protocol (OCEAN)	Data share market	▪ Mercedes-Benz	July 2020
Filecoin	Filecoin (FIL)	AI infrastructure	▪ Seagate, EY and AMD via Decentralized Storage Alliance	October 2022
iExec	iExec (RLC)	AI infrastructure	▪ NVIDIA Inception & IBM	October 2020
akash	Akash (AKT)	GPU compute	▪ Equinix Metal	March 2021
render	Render Network (RNDR)	GPU compute	▪ Potential partnership with Apple via parent company OTOY	June 2023
PHOENIX	Phoenix (PHB)	AI infrastructure	▪ WeChat, Tencent, JD.com	2021-2023
WORLDCOIN	WorldCoin (WLD)	AI infrastructure	▪ OpenAI CEO (Sam Altman) ▪ Multiple integrations[1]	2023
	Alethea (ALI)	Generative AI	▪ AWS	October 2023
IMGNAI	IMGNAI	AI generated images	▪ NVIDIA Inception	October 2023

Source: @layerggofficial, 10SQ

1) - Integrations with Discord, Talent Protocol, Okta's Auth0, Minecraft, Reddit, Telegram, Shopify, Mercado Libre, Minecraft, Reddit, Telegram, Shopify, and Mercado Libre

II. AI Applications for Web3

- One of the most substantive impacts of AI in the crypto space is code-writing tools (ChatGPT, Github Co-pilot). AI co-pilots allow developers to write more code on more blockchain networks. For instance, if you know Solidity but need to code in Rust on Cosmos, then you can ask ChatGPT/Co-Pilot to transcribe the code. AI code-writing tools lower the barrier to entry in blockchain and allow developers to write much more quickly.
- AI can be integrated into blockchain either on the infrastructure level (smart contracts, protocols, Web3 security) or on the level of decentralized applications (DApps):
  - **Blockchain Infrastructure Level:** AI can improve the core elements of blockchain infrastructure by creating intelligent smart contracts and intelligent consensus protocols that could make decisions based on dynamic on-chain data. It can also improve Web3 security by introducing AI-based detection systems. AI on-chain can also widen the design capabilities of crypto by allowing smart contracts to trustlessly query machine learning models, thereby giving rise to a new sector known as zero-knowledge machine learning (ZKML).
  - **Decentralized Application Level:** Decentralized applications can use AI techniques on-chain to analyze blockchain data, identify patterns, and automate tasks and decision-making. AI can provide more personalized experiences based on analyzing user behavior and preferences. AI will particularly create value and transform decentralized finance (DeFi) applications, Web3 gaming, metaverse, and NFT space.
- Some industry experts predict that crypto will become the currency of choice for AI agents, and most payments will be made on-chain by AI agents on behalf of people. While LLMs are unable to get access to bank accounts, they can easily make payments using a funded crypto wallet and are well-suited to interacting with the logic of smart contracts and DeFi protocols.

> AI on-chain has the potential to revolutionize decentralized networks and applications and drive massive adoption of Web3.

AI Applications for Web3 Infrastructure

- There are three main applications of AI to the core Web3 infrastructure:
- **Intelligent Smart Contracts**
- AI-based smart contracts can make decisions based on real-time on-chain data and not only on static rules. This way, smart contracts will make more accurate and efficient decisions.
  - Intelligent smart contracts are a new area of research, with only a few early-stage startups working there. For example, Oraichain uses AI-based APIs to create infrastructure for intelligent smart contracts and next-generation decentralized applications.
- **Intelligent Protocols**
- Researchers and startups have been developing AI-based approaches to consensus mechanisms. Consensus mechanisms determine the security and scalability of blockchains.
  - For example, Velas is working on an Artificial Intelligent Delegated Proof-of-Stake. Inery is developing a consensus mechanism to organize block validation based on uptime in the most efficient order.
- **Web3 Security**
- AI-based Web3 security solutions can detect cyber attacks and improve the security of blockchain projects. Security is a real obstacle to crypto adoption. Cryptocurrency hackers stole $3.8Bn in 2022, according to Chainalysis.
  - Most smart contract auditing and blockchain security firms have implemented AI-based security solutions, including such companies as Certik and Quanstamp. Hypernative, TestMachine, and CYVers are some of the new emerging startups focusing on AI-based solutions for Web3 security.
- Vitalik Buterin recently examined the use of AI as an actor, as an interface, as the rules themselves, and as an end objective in itself in his blog post.[1] He believes that the use of AI as an actor within a protocol has the highest viability, while using AI as an interface to a protocol has high potential but carries some risk. Buterin noted that the most challenging use of cryptocurrency and AI to get right would be applications that try to create a single, decentralized, trusted AI for other applications to rely on.

> *"In general, use cases where the underlying mechanism continues to be designed roughly as before, but the individual players become AIs, allowing the mechanism to effectively operate at a much more micro scale, are the most immediately promising and the easiest to get right."*
>
> *– Vitalik Buterin, co-founder of Ethereum*

> AI can make Web3 Infrastructure more intelligent, secure, and efficient. This is a new area of research with a few promising early-stage startups building here.

1) - There's too much trust in zero-knowledge tech by Misha Komarov, founder of =nil; Foundation, https://blockworks.co/news/theres-too-much-trust-in-zero-knowledge-tech

AI Applications for Web3 DApps

Decentralized Finance (DeFi)

- As DeFi systems become more mainstream, the massive amount of data they generate can be used to train and develop AI models. AI has the potential to unlock unprecedented opportunities and reshape the future of decentralized finance. Below are some of these use cases:
- **Utilizing AI algorithms for assessing borrower risk profiles:** AI algorithms can analyze historical lending information to create credit score ratings and to make more informed decisions regarding loan approvals, interest rates, and collateral requirements. For example, Spectral's on-chain credit score, the MACRO Score, is generated from a wallet's on-chain data and represents a sophisticated and constantly evolving machine learning model for DeFi lending.
- **Real-time monitoring for fraudulent activities:** AI algorithms can identify patterns of fraudulent behavior and potential red flags, such as unusual trading behavior, high-risk transactions, or suspicious addresses. Some centralized exchanges, like Binance and others, are already using AI for trade monitoring.

> *"AI and Blockchains are made for each other. Provenance of data, machine generated and enforced contracts, and machine to machine value exchange. We are already hearing about AI Bots spinning up on-chain wallets and using USDC."*
>
> *– Jeremy Allaire, CEO of Circle*

- **AI-powered trading strategies and trading bots:** By leveraging AI-powered trading bots and predictive analytics, traders can optimize their trading decisions and capitalize on market trends and opportunities. For example, 3Commas operates a cryptocurrency trading bot platform to help traders automate their trading strategies.
- **Predictive analytics:** AI can analyze market conditions in real-time and assist DeFi platforms in making more informed risk decisions. For example, Numerai's blockchain-based hedge fund utilizes artificial intelligence and crowdsourced stock market predictions to optimize the platform's investing approach. The company functions as a platform disseminating encrypted financial data sets to a global network of 5.5k data scientists who utilize machine learning to develop predictive models for signaling stock market trades.[1] Data scientists can gain tokens by building models that perform well on the data sets provided by Numerai or lose tokens if their stock predictions underperform.
- **AI-driven portfolio management and automated asset rebalancing** for on-chain asset allocation and portfolio performance optimization. For example, FluidAI operates an AI-enabled liquidity aggregator platform to tackle fragmented liquidity in virtual asset markets.
- **AI-enabled payment infrastructure**, where AI agents can make payments on behalf of their users in accordance with rules and strategies. For example, Fetch.Ai offers a service where you can create an AI agent to make payments on your behalf.

> From automated trading algorithms and risk assessment models to fraud detection systems, the applications of AI in DeFi are vast and promising.

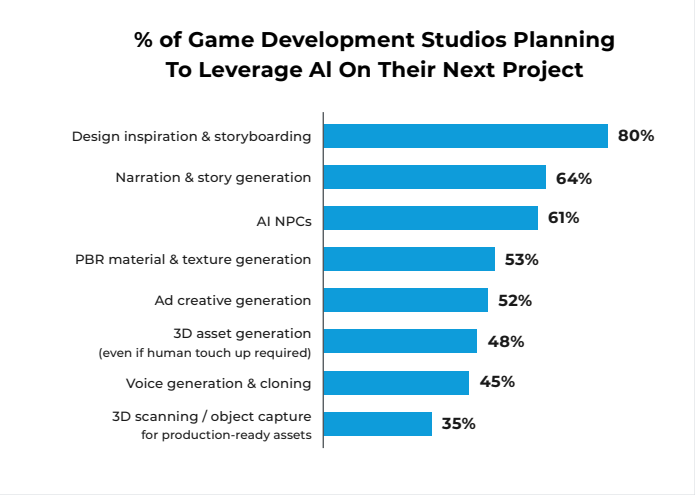
Blockchain Gaming and Metaverse

- AI and metaverse can transform the future of user experiences, making them more user-centric. User privacy and safety are prominent concerns in adopting AI for the metaverse. Some of the applications of AI in Web3 gaming and metaverse:
- **Nonplayable characters (NPCs):** Generative AI could personalize interactive stories for each player. For example, Inworld AI became a leading character engine for AI NPCs. Also, AI can make games, like WebKinz and NeoPets, where people spent millions to take care of pets and items, more immersive.
- **New generated environments:** Users could generate virtual worlds with interactive AI agents based on past storylines and game user interactions. For example, ASM, a division of Futureverse, is developing an AI-based decentralized platform that allows users to interact with AI Agents across gaming worlds.
- **New types of on-chain games.** Co-operative human versus AI games and other innovative takes on on-chain games could emerge where a trustless AI model can act as a nonplayable character. For example, AI Arena is developing a web play-to-earn (P2E) fighting game in which players design, train, and battle AI-powered NFTs in a global arena competition.

> *"If we think about AIs transacting with each other as autonomous beings in the future, what currency they will transact in, it has to be crypto. In the future, 70-80% of transactions will happen through autonomous AI agents, and the decentralized nature of crypto makes it a perfect match."*
>
> *– Yat Siu, CEO of Animoca Brands*

1) - https://tokenhell.com/numerai-a-comprehensive-guide-to-the-ai-powered-hedge-fund/

- **In-game economic rebalancing:** AI can dynamically rebalance an in-game economy by adjusting token issuance, supply, and voting thresholds.
- **AI-powered personalized experiences:** Companies can create AI agents capable of responding intuitively to customer sentiment by analyzing customer behavior and preferences data. For example, Alethea AI is a decentralized protocol powering a growing metaverse (named Noah's Ark) of Intelligent and Interactive NFTs (iNFT).
- **Content recommendation and target advertising:** AI can enable NFT marketplaces and Web3 social networks to provide more personalized content to their users and recommend more relevant products. For example, PLAI Labs builds the next generation of social platforms by leveraging AI and Web3.



Source: AI x Game Development Survey, May 2023, A16z

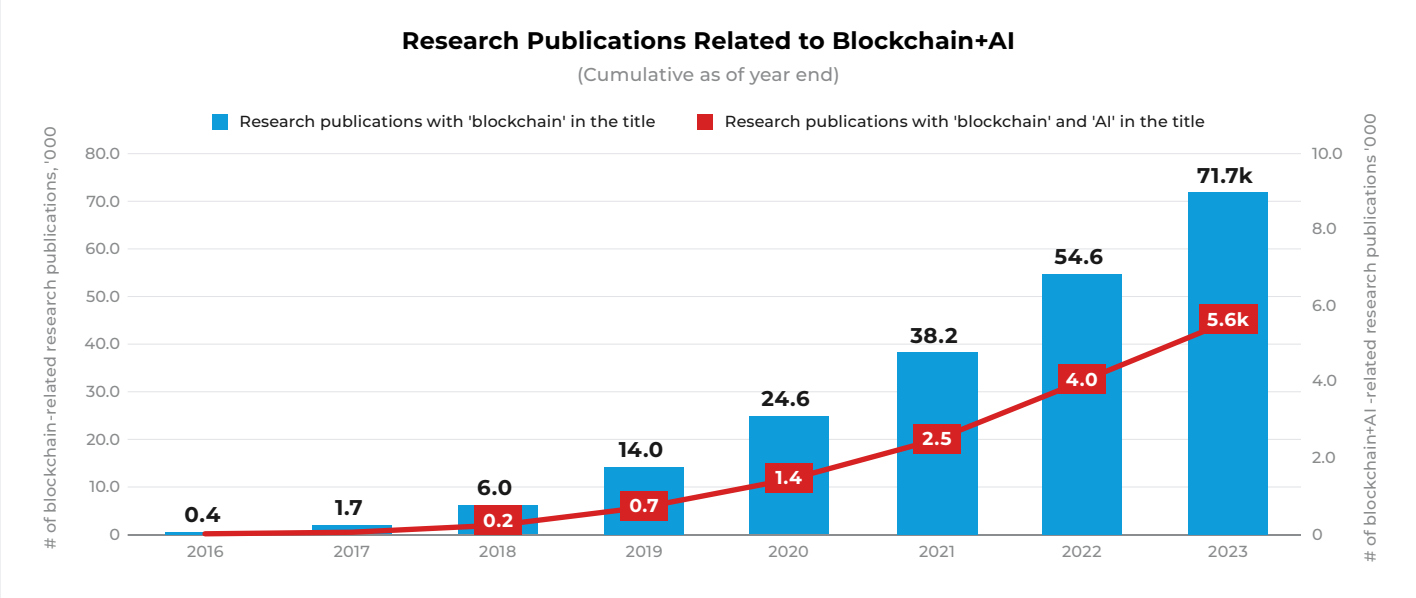
Other Use Cases

- **Healthcare**
  - **Secure and interoperable records:** AI can analyze health records, clinical transcripts, and medical imaging. Patient data can be stored on blockchain and shared across healthcare providers with confidence that it is safely protected.
  - **Drug development and clinical trials:** By analyzing scientific literature, genetic data, and clinical trials, AI algorithms can accelerate the discovery of potential drugs, modeling of new molecules, and folding of different proteins. Integrating blockchain can increase the transparency and validity of clinical trial data. For example, DVLP Medicines is building a new infrastructure for drug development by using blockchain and AI. DVLP Medicines is automating the process of drug development by digitizing drug assets, financing, and development workflows.
  - **Telemedicine and patient-generated data:** AI can analyze patient-generated data and provide insights tailored to each person. Blockchain can enable secure storage and sharing of this data, which ensures patient privacy. For example, Pulse Application is a new health and lifestyle app that combines blockchain and AI to track user data.
  - **Billing and claims management:** AI can automate billing, claims management, and insurance verification. Blockchain can help ensure these processes are transparent. It can help prevent fraud and provide faster and more accurate reimbursements. For example, Chronicled is developing an automated business rule enforcement in the healthcare industry through the blockchain-powered MediLedger Network.
- **Supply chain and commerce**
  - **Traceability, efficiency, and accuracy:** While blockchain is used in supply chains to track products up to their source, AI can use historical sales data to generate demand forecasts and plan distribution routes. For example, DiMuto uses blockchain technology and AI to provide agriculture trade solutions, including determining product quality.

III. The State of Web3+AI In 2023

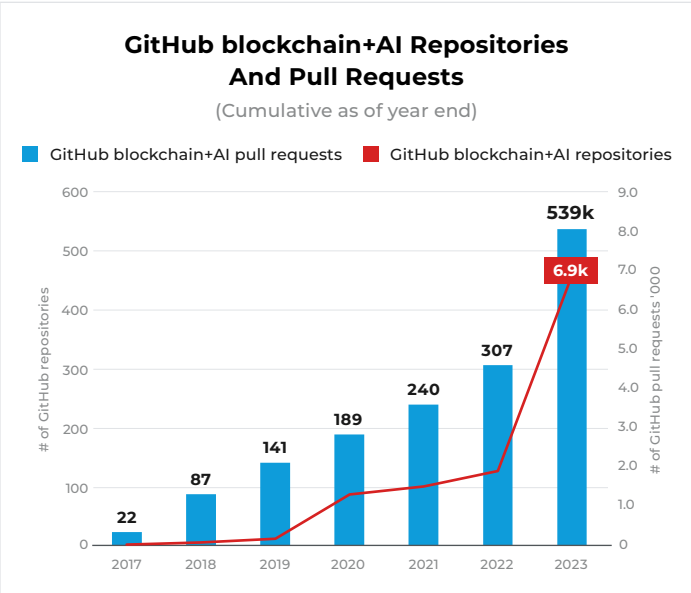
- The blockchain+AI-related research is a fast-growing area of blockchain research.
- Over 5.6k research publications dedicated to blockchain+AI were published over the last five years.
- The number of blockchain+AI-related research publications, patents, and GitHub repositories and pull requests has been consistently rising over the last five years.

Rising research interest in the blockchain+AI field

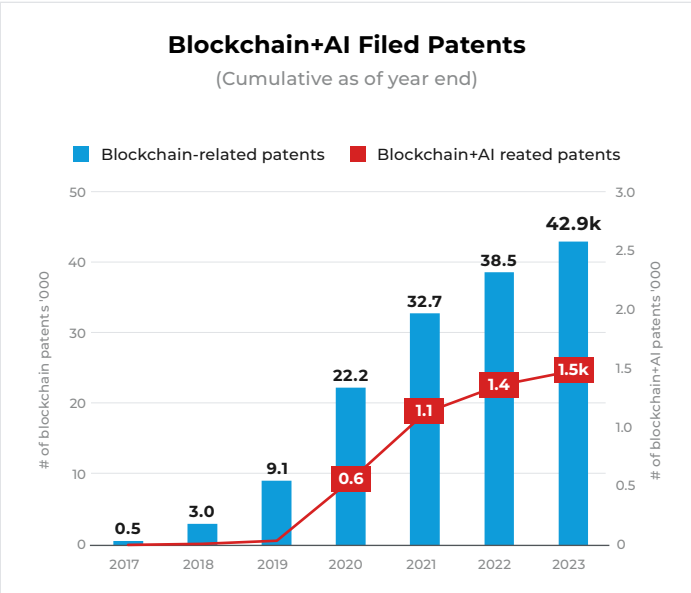


Source: Dimensions.ai

- The developer activity in the emerging field has been gradually picking up, which is demonstrated by the growing number of new GitHub repositories and pull requests.

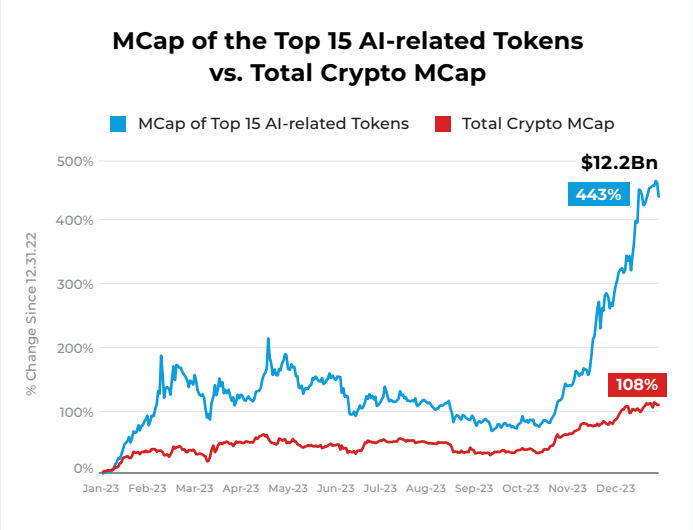


Source: GitHub, search based on public repositories "blockchain" in topic, "AI" in description

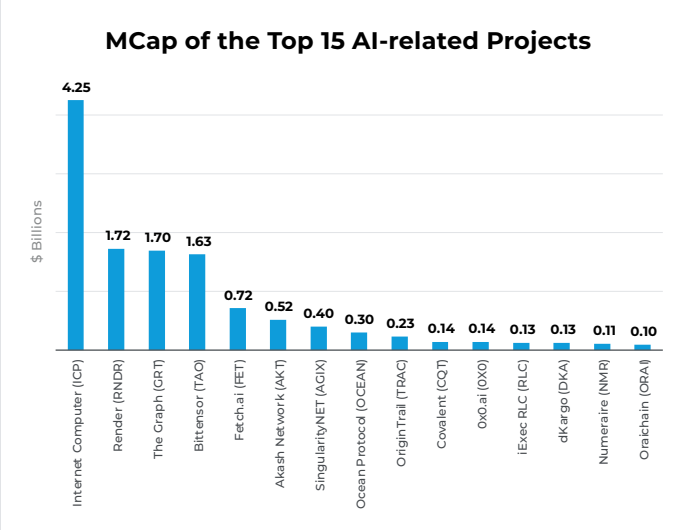


Source: World Intellectual Property Organization

- The price of AI-related tokens has been showing a notable growth, signaling a growing interest and confidence in the AI on-chain.
- The market capitalization of the top 15 AI-related tokens reached $12Bn as of December 31, 2023, having grown 443% in 2023 compared to a 108% growth of the total crypto market.



Source: CoinGecko



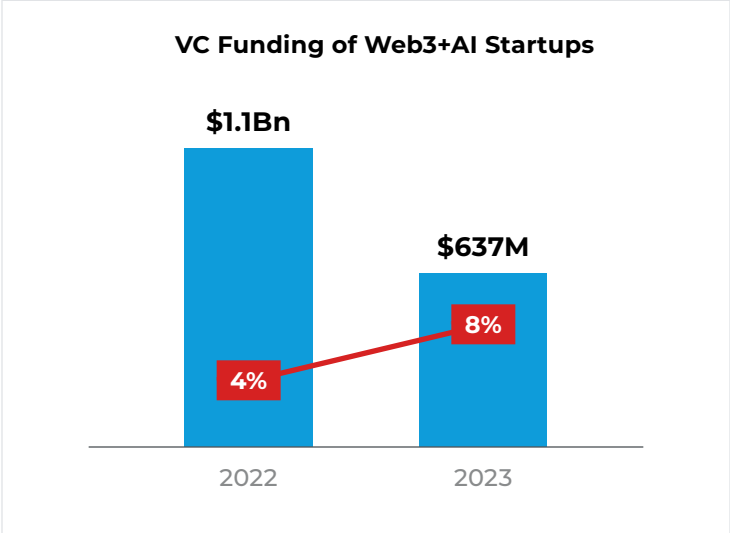
Source: CoinGecko

Note: Top-15 AI tokens include ICP, TAO, RNDR, GRT, OCEAN, AGIX, FET, DKA, NMR, RLC, 0x0, CQT, AKT, TRAC, ORAI, as of December 31, 2023

AI-Related tokens attracted considerable investor interest: 5.5x growth of the top 15 AI-related projects market capitalization in 2023.

- Despite the slowdown in VC funding this year, Web3+AI was one of the most popular categories among investors in blockchain startups this year, commanding over 11% of the total VC funding in blockchain.
- The VC funding of Web3+AI startups has exceeded $0.6Bn in 2023.

Web3+AI startups receive increasing share of investor support.



Source: Pitchbook

Note: AI startups include startups focusing on artificial intelligence, machine learning & big data

IV. How Can AI Create Value For Existing Digital Asset Ecosystem Players?

- Besides new use cases, AI technology could significantly affect existing companies operating in the digital asset ecosystem (DAE).
- McKinsey estimates that the economic effect on the value of incremental increases in productivity for existing companies (35-70%) will exceed the incremental impact of new AI use cases (15-40%).[1] Approximately 40% of surveyed enterprises already consider building enterprise-specific language models internally.
- AI could improve the existing DAE companies' business models in the following ways:
- **Reduce costs:** AI can add value by automating existing workflows or repetitive tasks and capturing and acting on real-time information. Across all industries, about three-quarters of the value from generative AI would emerge from four areas of business: customer operations, marketing and sales, software engineering, and research and development, according to McKinsey. This is also true for DAE companies.
- **Increase revenue:** AI enables companies to better upsell/cross-sell products, increase customer retention, expand growth from new product releases, charge premiums for AI-integrated services, increase price over time as the value proposition and stickiness of existing products grow with the integration of AI. Web3 businesses operating in financial services, infrasrtucture, and data & forensics are well-positioned to use AI to increase revenue.
- **Build moats:** As businesses use AI to increase user interactions and retention, they'll also collect more data, which can help build better models and more personalized services.

Potential Impact Of AI On Crypto Data Companies

Categories	Building Moat		Impact on Revenue Growth		Impact on Expenses
On-chain data providers, oracles, data querying	✓ ✓ ✓	50%+[2]	New AI-powered capabilities, new services and products, and potential revenue expansion opportunities into data analytics, forensics, and trading. Oracles, connecting blockchains to external data sources and allowing smart contracts to plug into real-world data and make transaction decisions, will particularly benefit from the growth of AI.	- (5-10%)	Optimization of operating expenses, smaller customer support and engineering teams, AI fraud prevention technologies, and enhanced risk management using predictive analytics.
Data storage and transfer infrastructure	✓ ✓ ✓	10-50%	Decentralized data storage and transfer infrastructure could play an essential role in building the future of decentralized AI. We expect an increased demand for such products and services, as well as significant future revenue opportunities for companies providing such services.	- (5-10%)	Optimization of operating expenses, smaller customer support and engineering teams, AI fraud prevention technologies, and enhanced risk management using predictive analytics.
Web3 Security, smart contract audit Forensics and compliance	✓ ✓	10-50%	There is an opportunity for new AI-powered services that can get premium pricing, e.g., reinforcement learning for cyber security models, AI-powered KYC/AML, etc. Many smart contract auditing and blockchain security firms have already implemented AI-based security solutions.	- (5-10%)	Optimization of operating expenses, smaller customer support and team, use of AI fraud prevention technologies, enhanced risk management using predictive analytics.
Data analytics, research, industry news	✓	5-10%	There is an opportunity to develop new AI-powered and more sophisticated data products, e.g., AI-based data products for trading and portfolio management, automated token analytics, etc. There is a risk that new AI-powered services can cannibalize some of the traditional data analytics products, especially for news media companies.	- (5-10%)	Optimization of operating expenses, smaller customer support and engineering teams, AI fraud prevention technologies, and enhanced risk management using predictive analytics.

1) - McKinsey, AI could increase corporate profits by $4.4 trillion a year, according to new research, July 2023
2) - Estimated annual effect

- The global data creation and replication will experience a compound annual growth rate (CAGR) of 23% over the forecast period, leaping to 181 zettabytes in 2025.[1] That's up from 64.2 zettabytes of data in 2020, which, in turn, is a tenfold increase from the 6.5 zettabytes in 2012.
- In contrast to many industries, where data is located in messy and siloed legacy systems, blockchain has a great differentiator – it has on-chain data, which is organized in a proscribed way, and the usage of blockchain generates even more on-chain data.
- As more transactions are processed on-chain, the amount of data stored on the blockchain increases exponentially and becomes more digestable.

> We expect that blockchain-based data infrastructure (Dune Analytics, Spice AI, Filecoin, Akash, Space and Time, and others), as well as Web3 security companies (Certik, Quantstamp, Hypernative, Testmachine, and others) will be some of the main beneficiaries of the rise of AI.

Potential Impact Of AI On Crypto Infrastructure Companies

Categories	Building Moat		Impact of AI on Revenue Growth		Impact of AI on Expenses
Developer tools	✓ ✓ ✓	50%+[2]	One of the most substantive impacts of AI in the crypto space is code-writing tools (ChatGPT, Github Co-pilot). AI co-pilots allow developers to create more in blockchain and write code on more chains. We expect a significant demand for services that help integrate AI into traditional business models.	- (5-10%)	Optimization of operating expenses, including marketing expenses, smaller customer support, and software engineering teams.
Decentralized identity and privacy solutions	✓ ✓ ✓	50%+	Decentralized identity and privacy solutions could become some of the most in-demand services in the AI-enabled world. As AI capabilities continue to evolve, proving data and content authenticity becomes a priority.	- (5-10%)	Optimization of operating expenses, including marketing expenses, smaller customer support, and software engineering teams.
Decentralized Physical Infrastructure (DePIN) networks	✓ ✓ ✓	50%+	DePINs incentivize individuals to gather real-world data, typically through sensors. This approach offers a valuable means of collecting real-world data that can be utilized for training purposes. We expect significant demand for the data and services of DePIN networks.	- (5-10%)	Optimization of operating expenses, including marketing expenses, smaller customer support, and software engineering teams.
Nodes infrastructure	✓ ✓	10-30%	Potential premiums for AI-enabled new services. AI could be used to predict future network demand, optimize resource allocation, and detect and prevent security threats.	- (10-20%)	AI can automate many tasks that currently require human intervention, leading to increased efficiency and reduced downtime. The AI system could be programmed to monitor the network for any unusual activity, such as a hacking incident.
Staking infrastructure	✓	10-30%	New revenue opportunities in AI-powered staking services: AI algorithms can assess various parameters, such as staking reward rates, network participation levels, and token price movements, to determine the most attractive staking options. AI can dynamically adjust staking strategies based on real-time market conditions, ensuring investors capitalize on the best opportunities available.	- (5-10%)	AI can automate many tasks that require human intervention, freeing up time and resources for other aspects of staking management. Optimization of operating expenses, smaller customer support, and software engineering teams.

> AI has the potential to revolutionize blockchain infrastructure companies, leading to increased efficiency and security of blockchain networks. Main beneficiaries: Worldcoin, Fetch.ai, Chain.ML, Risc Zero, DIMO, and others.

1) - IDC, Global Data Forecast 2021-2025
2) - Estimated annual effect

Potential Impact Of AI On Crypto Financial Services

Categories	Building Moat		Impact of AI on Revenue Growth		Impact of AI on Expenses
Stablecoin issuers, tokenization services, payment infrastructure providers	✓ ✓ ✓	50%+[1]	As crypto becomes the currency of choice for AI agents, the revenue opportunities for stablecoin issuers, tokenization providers, and payment infrastructure will expand. LLMs can easily make payments using a funded crypto wallet and are well-suited to interacting with the logic of smart contracts and DeFi protocols.	- (10-20%)	Optimization of operating expenses, use of AI fraud prevention, AI-enabled technologies in AML/KYC, enhanced risk management using predictive analytics, smaller customer support teams, etc.
Decentralized Finance	✓ ✓ ✓	50%+	Significant impact on revenue through new products in lending, yield farming, algotrading, AI-enhanced portfolio strategies and protocols, and other AI-based products and services.	- (5-10%)	Companies operating in DeFi usually have an optimized expense structure. Further optimization is possible by adding fraud prevention systems and reducing software engineering and marketing expenses.
Trading firms & trading infrastructure providers, portfolio managers	✓ ✓ ✓	10-50%	Significant impact on revenue through new products in algotrading, AI-powered trading bots, robo-advisory, AI-enhanced portfolio strategies, etc.	- (5-10%)	Optimization of operating expenses, use of AI fraud prevention, AI-enabled technologies in AML/KYC, enhanced risk management using predictive analytics, smaller customer support teams, etc.
Centralized crypto exchanges	✓ ✓	5-10%	Direct impact on revenue from the overall increase in the crypto market activity of asset managers, trading firms, and DeFi. Better client targeting via enhanced AI-based marketing technologies. Additional revenue from new products in data analytics.	- (10-20%)	Optimization of operating expenses, smaller customer support and software engineering teams, use of AI fraud prevention technologies in AML/KYC, real-time monitoring of transactions for fraudulent activities, and enhanced risk management using predictive analytics.
Custodians	✓	5-10%	Indirect impact on revenue through increase in clients' financial activity in sectors like trading and asset management.	- (5-10%)	AML/KYC and real-time monitoring of transactions for fraudulent activities. Enhanced risk management using predictive analytics. Reduced software engineering expenses.

- Traditional finance companies are experiencing significant financial benefits from enabling AI across their organizations.
- According to a 2022 survey by NVIDIA, over 75% of companies operating in the financial sector apply machine or deep learning to optimize their internal operations.[2]
  - 35% of respondents said the applications created operational efficiencies.
  - 28% in 2022 of respondents indicated they decreased annual costs by more than 10%.
  - Over 30% of respondents stated that AI increases annual revenues by more than 10%.
- AI could facilitate the complete personalization of finance, where each user receives the specific financial help they need, tailored to their financial situation. Experts predict that AI automation could reduce the cost of serving users by up to 80% across traditional fintech companies, which also involves lower costs of user acquisition.
- Considering the interconnected and compounding nature of AI and blockchain technologies, the effect on the economics of crypto financial services companies can be much larger than in traditional finance.

Top AI use cases in financial services (excluding China)	
Natural language processing (NLP) / large language models (LLMs)	26%
Recommender systems / next-best action	23%
Portfolio optimization	23%
Fraud detection: transactions/payments	22%
Fraud detection: anti-money laundering / know your customer	22%
Algorithmic trading	21%
Conversational AI	20%
Marketing optimization	20%
Creating synthetic data for model creation/optimization	20%
Synthetic data generation	18%
Document management	18%
Compliance	17%
Default prediction	15%
Environmental, social, and governance (ESG)	12%
Metaverse/virtual worlds	12%
Claims processing	12%

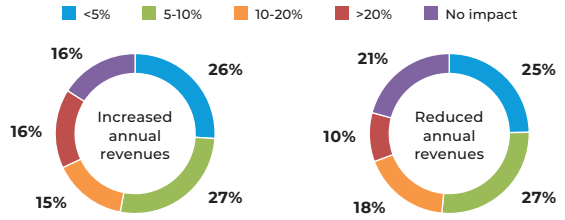
Source: NVIDIA, State of AI in Financial Services 2023 Trends

1) - Estimated annual effect

2) - NVIDIA, State of AI in Financial Services 2022 Trends

AI can bring significant changes to the crypto financial sector, with its potential being similar to that of computer-driven trading models introduced by wall street traders in the 1980s. Main beneficiaries: Circle, Tether, Spectral Finance, and others.

Results of the NVIDIA survey of 500 financial services professionals on the use of AI in their organizations:



Source: NVIDIA, State of AI in Financial Services 2022 Trends

Potential Impact Of AI On Blockchain Gaming And Metaverse

Categories	Building Moat	Impact of AI on Revenue Growth		Impact of AI on Expenses
Gaming studios, metaverses	✓ ✓ ✓	10-50%[1]	New revenue sources include game releases, premiums for AI-integrated products or services, and potential price increases as the value proposition and product stickiness grow with the integration of AI. AI will give powerful developer tools to extend the lives of popular titles.	- (15-30%)	Live community management and player support can be significantly improved by using AI-based techniques. AI will give powerful developer tools to manage virtual economies within games and metaverses eliminating the need for large teams of data scientists and engineers.
Creators of NFT art and other NFT collectibles	✓ ✓	5-10%	AI-generated artworks have gained substantial value in the NFT market. As the NFT ecosystem evolves, AI-generated art continues to contribute to the diversity and value of digital collectibles. The NFT aspect of AI-generated artworks offers a means of authentication through blockchain.	-(5-10%)	AI has the potential to disrupt traditional art creation processes by automating certain steps of artistic production; however, compared to other subsectors, we see few cost optimization opportunities in art NFT creation.
NFT marketplaces and NFT finance	✓ ✓	5-10%	Personalized recommendations and content curation streamline user interactions with NFTs, increase user retention, and AI-driven security measures create a safe environment for transactions. Price premiums are possible for AI-integrated services, like AI-based NFT valuation and NFT price prediction.	- (30-50%)	Optimization of operating expenses, smaller customer support and software engineering teams, use of AI fraud prevention technologies, enhanced risk management using predictive analytics.
Social media, consumer apps, and advertising	✓ ✓	5-10%	AI tools will enable a number of use cases in social media, including ad management, brand awareness campaigns, text and visual content creation, social media monitoring, influencer research, personalized recommendations, and more.	- (10-20%)	Optimization of operating expenses, including marketing expenses, smaller customer support, and software engineering teams, and enhanced risk management using predictive analytics.

- According to an A16z survey, 87% of gaming studios already use an AI tool or model, and 99% of studios plan to use AI in the future.[2]
- Today, most studios use horizontal, non-game-specific tooling (ChatGPT/GPT-3/4; Midjourney; Copilot; etc.). More vertical tools targeting game developers (3D asset generation, AI NPC platform, AI Playtesting) will eventually penetrate studios.
- Video game industry executives believe that within 5 to 10 years, AI could manage more than half of game development.

AI will form a crucial building block for the future development of Web3 gaming, metaverse, and NFT-focused businesses. Major beneficiaries include Animoca Brands, Inworld.ai, Horizon Blockchain, and more.

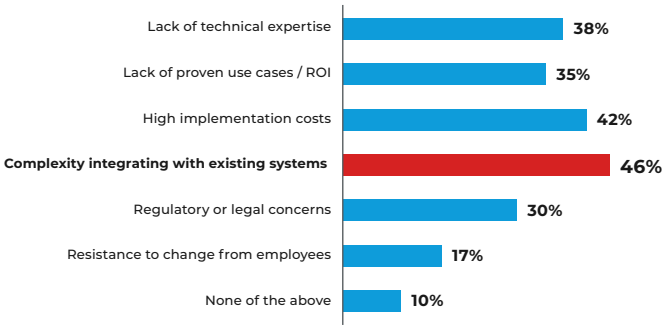
1) - Estimated annual effect
2) - https://twitter.com/tkexpress11/status/1671879727395774464?s=20

V. Challenges To Adoption And Implementation Of Blockchain+AI

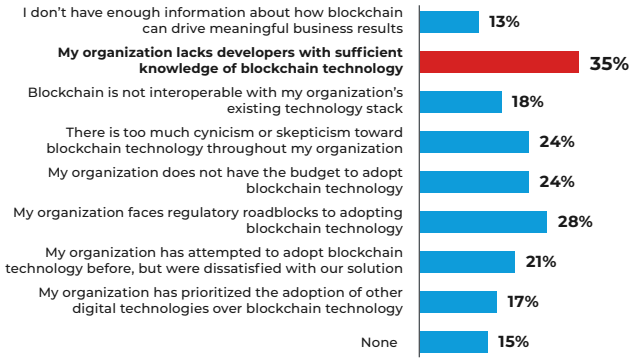
- **Scalability issues:** AI applications often need high-speed processing and low-latency communication, which can be difficult to achieve on blockchain networks with limited throughput and slow consensus mechanisms. Blockchain networks are still being developed and may not be able to process the high volume and complexity of data that AI systems require. Computers get faster, but the internet not so much.
- A lack of developers with sufficient knowledge of blockchain technology remains one of the main obstacles to blockchain and AI implementation.

> ***"There are indeed some promising applications of AI inside of blockchain ecosystems, or AI together with cryptography, though it is important to be careful about how the AI is applied. A particular challenge is: in cryptography, open source is the only way to make something truly secure, but in AI, a model (or even its training data) being open greatly increases its vulnerability to adversarial machine learning attacks."***
>
> *– Vitalik Buterin, co-founder of Ethereum*

What challenges do you anticipate in integrating AI and blockchain technology within your organization?



Which of the following best describes an obstacle to blockchain adoption that your organization faces?



Casper Labs, Survey: Blockchain Meets AI: Exploring the Challenges and Opportunities of Integration, November 2023. Casper Labs commissioned Zogby Analytics to conduct an online survey of 608 IT decision-makers in six countries: the US, the UK, China, Germany, Austria, and Switzerland.

- **Compatibility issues:** AI relies on data stored and processed in centralized servers or cloud platforms, while blockchain is a decentralized node network that stores and verifies transactions in encrypted blocks. Complexity integrating with existing systems is by far the most prevalent concern about implementing blockchain and AI technology.
- **Accessibility issues:** While blockchain often lacks intuitive interfaces and clear applications for easy adoption by everyday users, AI was able to package complex operations into user-friendly applications, for example, ChatGPT, Siri, and Alexa. To achieve levels of adoption similar to AI, blockchain may need to find ways to simplify user interactions.
- **Governance issues:** AI and blockchain have different models of governance, which can affect how they are regulated and controlled. AI is often governed by centralized authorities, such as developers, owners, or regulators, who can influence its behavior, goals, and outcomes. Blockchain, in contrast, is governed by decentralized protocols, such as consensus rules, incentives, or voting mechanisms, which the network participants enforce. The challenge lies in balancing pure decentralization with delivering performant, real-world systems.
- **ZK technology issues:** Zero-knowledge (ZK) technology, in a Web3 context, is still fairly new. Developers are actively addressing ZK tech's current issues, but the innovative nature of the space means that they are often conceptualizing faster than they can build.[1] ZK technology space has also gotten to a point where it risks overcomplicating itself. There is a growing knowledge gap between ZK builders and Web3 users.
- Other issues facing ZK tech development include optimizing time-to-market without compromising on the integrity of projects. ZK proofs and circuits currently lack accessibility, because developers need to learn domain-specific languages (DSLs) to enable further proving of these computations. This is a problem because only a handful of people globally have firsthand knowledge of DSLs and cryptography.

> AI and blockchain are currently at different acceptance levels, but they are not incompatible. Integrating these two technologies can bring about tremendous synergies.

1) - There's too much trust in zero-knowledge tech by Misha Komarov, founder of =nil; Foundation, https://blockworks.co/news/theres-too-much-trust-in-zero-knowledge-tech

Appendix: Web3+AI Startup Ecosystem

Overview of Web3+AI Startup Ecosystem

Selected Profiles of Web3+AI Companies

Compute Networks

akash	▪ The Akash Network is an open-source Supercloud that allows users to securely and efficiently buy and sell computing resources. It enables users to own their cloud infrastructure, deploy applications, and rent unused cloud resources. Akash operates as a decentralized public utility, utilizing a "reverse auction" system that often offers up to 85% lower prices than other cloud systems. The network is owned and managed by its community and built on dependable technologies like Kubernetes and Cosmos.	▪ Founded in 2015 in SF, CA ▪ $3M raised to date ▪ MCap $548M (Dec 31, 2023) ▪ Investors – Goldfingr, Recursive Ventures, RR2 Capital, and more
RISC ZERO	▪ The RISC Zero zkVM is a verifiable computer that works like a real embedded RISC-V micro-processor, enabling programmers to write ZK proofs like they write any other code. The RISC Zero platform is based on zk-STARKs and the RISC-V microarchitecture. The company is creating the infrastructure & tooling for Web3 developers around the globe to build zero-proof software.	▪ Founded in 2021 in Seattle, WA ▪ Raised to date $54M / last round valuation - $150M ▪ Investors – Alchemy, Blockchain Capital, Figment Capital, Galaxy Digital, Bain Capital, Cota Capital, IOSG VC, and others
Flux	▪ Flux is a decentralized blockchain platform for deploying DApps, databases, and computational jobs in a trustless manner. The native token, Flux (FLUX), is utilized within its ecosystem to facilitate various operations and incentivize user participation. FLUX tokens are used for staking, governance, node operations and are awarded as block rewards to sustain the network's security and performance.	▪ Founded in 2019 in SF, CA ▪ Raised $12M to date ▪ MCap - $216M (Dec 31, 2023) ▪ Investors – Bain VC, 8VC, Studio Management, others
bittensor	▪ Bittensor is a decentralized network that incentivizes knowledge production by rewarding participants for servicing knowledge exchange through their unique ML models. By implementing a decentralized mixture of experts (MoE), Bittensor combines specialized models to create a more accurate overall model, enabling efficient problem-solving: • Effectively offers individuals and small labs the opportunity to contribute to AI development and monetize their work, regardless of their size or niche. • Facilitates knowledge sharing, allowing models to exchange information & accelerate their learning.	▪ Founded in 2019 in Toronto, Canada ▪ MCap - $1.6Bn (Dec 31, 2023) ▪ Investors - Polychain, FirstMark Capital, DCG
render	▪ The Render Network is the first decentralized GPU rendering platform, empowering artists to scale GPU rendering work on-demand to high-performance GPU Nodes. Through a blockchain marketplace for idle GPU compute, the network allows artists to scale next-generation rendering work at fractions of the cost and orders of magnitude increases in speed compared to the centralized GPU cloud. In the first half of 2023, Render Network successfully processed over 4.6 million frames, providing an exceptionally cost-effective solution compared to other rendering farms, with an average subscription cost of $20 per month.	▪ Founded in 2017 in LA, CA ▪ MCap - $1.7Bn (Dec 31, 2023) ▪ Parent company OTOY raised $97M to date/ last round valuation - $313M
together.ai	▪ Together.ai is a decentralized cloud for artificial intelligence. The company's platform is involved in building large, open models that are easy to use and are open source, enabling researchers, developers, and companies to leverage and improve artificial intelligence with an intuitive data, models, and computation platform.	▪ Founded in 2022 in Menlo Park, CA ▪ Raised $24M to date, last valuation - $100M ▪ Investors - Lux Capital, Cadenza, Robot Ventures, Alex Attalah, and others
gensyn	▪ Gensyn is a decentralized machine learning compute protocol. The protocol enables developers to build AI systems on smaller data centers, personal gaming computers and other connected hardware and to pay on demand. Gensyn uses a cryptographic verification network that, without the need for intermediaries, allows users to determine that machine learning work shared over the protocol has been finished correctly.	▪ Founded in 2020 in London/Tel Aviv ▪ Raised to date $52M ▪ Investors - A16z, Galaxy Digital, Coinfund, Maven 11, and others
Modulus Labs	▪ Modulus Labs is building trustless AI with zero-knowledge proofs to make the technology cheaper and more accessible for crypto protocols. The startup's system delivers inexpensive AI integrated with blockchain security for less than a cent. Its current customers include WorldCoin.	▪ Based in Stanford, CA ▪ Raised $6M at $25M ▪ Investors - Celestia, Worldcoin, Standard Crypto, Polygon, Inflection and 8 more
Giza	▪ Giza is an artificial intelligence platform for smart contracts and Web3 protocols. Giza is trying to unlock machine learning capabilities for Web3 smart contracts and protocols leveraging collective and open development. Giza is using zero-knowledge cryptography to bring model inferencing on-chain.	▪ Founded in 2022 in Switzerland ▪ Raised to date - $3M ▪ Investors – Arrington Capital, Coinfund, TA Ventures, Starkware, and others

Source: Pitchbook, Coingecko, company websites, press releases
As of December 31, 2023

Singularity Net	▪ SingularityNET is a decentralized AI marketplace that operates on blockchain technology. Their primary goal is to develop Artificial General Intelligence (AGI) for the beneficial advancement of technology. They offer various services and products, including the AI Marketplace and AI Publisher, which allow users to access and integrate AI algorithms into their applications. SingularityNET also provides tools like AGIX Staking and the Bridge for token management and cross-chain transfers.	▪ Founded in 2017 in Amsterdam, NL ▪ MCap - $408M (Dec 31, 2023) ▪ Raised to date $25M ▪ Investors – Decentral Park Capital, Algorand, LDA Capital, Alpha Sigma Capital, others
fetch.ai	▪ Fetch.ai is an AI company that provides infrastructure for smart, autonomous services. Their platform allows users to build, deploy, and connect smart agents for automating Web3 systems and transforming business models. Through their technology, users can create open services using automation and AI in various sectors such as supply chain, finance, travel, and predictions. Fetch Network aims to reinvent the way we live and work by enabling agents to learn, predict, and undertake meaningful tasks in the real world.	▪ Founded in 2017 in Austin, TX ▪ MCap - $715M (Dec 31, 2023) ▪ Raised $75M to date ▪ Investors – Spark Digital, Fireblocks, GDA Capital, Outlier Ventures, others
ocean	▪ Ocean Protocol is a data-focused platform that provides next-generation tools to unlock and utilize data at scale. Users can develop and customize applications using Ocean's JS and Py libraries, earn rewards by locking OCEAN tokens and curating data, and engage with the data science community through data challenges. Ocean Protocol is known for its work in the field and has been recognized as a World Economic Forum Technology Pioneer.	▪ Founded in 2017 in Singapore ▪ MCap - $303M (Dec 31, 2023) ▪ Raised $5M to date ▪ Investors – Outlier Ventures, Amino Capital, Kosmos Ventures, Moonrock, First Principles VC, IOSG VC, others
ChainML	▪ ChainML is building a scalable, censorship-resistant protocol for machine learning and related complex data-driven computation for Web3. ChainML plans to create its first iteration of the ChainML protocol, simplifying the use of AI and machine learning models in smart contracts, DApps and wallets.	▪ Founded in 2022 in SF, CA ▪ Raised $4M ▪ Investors – IOSG VC, Hashkey, Alliance DAO, others

Blockchain-based Privacy Solutions for AI

RISC ZERO	▪ The RISC Zero zkVM is a verifiable computer that works like a real embedded RISC-V micro-processor, enabling programmers to write ZK proofs like they write any other code. The RISC Zero platform is based on zk-STARKs and the RISC-V microarchitecture. The company is creating the infrastructure & tooling for Web3 developers around the globe to build zero-proof software.	▪ Founded in 2021 in Seattle, WA ▪ Raised to date $54M/ last round val.- $150M ▪ Investors – Alchemy, Blockchain Capital, Figment Capital, Galaxy Digital, Bain Capital, Cota Capital, IOSG VC, others
Aztec	▪ Aztec is a company that offers a first-of-its-kind hybrid zkRollup solution, supporting both public and private smart contract execution on the Ethereum network. They provide encrypted apps that combine the benefits of Ethereum smart contracts with programmable privacy. Aztec's innovative architecture and smart contract language, Noir, enable developers to create applications that prioritize user privacy, flexible compliance, and new gaming experiences.	▪ Founded in 2017 in London, UK ▪ Raised to date - $103M/ last round val. - $530M ▪ A16z, Hashkey, Alumni Ventures, IOSG VC, Paradigm, Variant Capital, A.Capital, Coinbase, Consensys, etc
FHENIX	▪ Fhenix Protocol - is the first confidential blockchain powered by fully homomorphic encryption. Through the usage of fhEVM, Fhenix enables Ethereum developers to seamlessly build encrypted smart contracts and perform encrypted computation of data, all while using Solidity and other familiar, easy-to-use tools. Fhenix was incubated in 2023 out of a private partnership between SCRT Labs and Zama.	▪ Founded in 2023 in Tel Aviv, Israel ▪ Raised $7M ▪ Investors – Multicoin, HackVC, Robot Ventures, Collider Ventures, others
auradine	▪ Auradine is developing a broad range of infrastructure across hardware and software, including energy-efficient silicon, zero-knowledge proofs (a blockchain-based privacy tool), and artificial intelligence (AI) solutions for decentralized applications. In November 2023, Auradine announced the debut of its Teraflux AT2880 and AI3680 bitcoin miners with efficiency rates of 15 - 16 J/T and a maximum output of 375 TH/s – the fastest in the world, according to the company's press release.	▪ Founded in 2022 in Santa Clara, CA ▪ Raised $80M/ Last round valuation - $640M ▪ Investors: DCVC, Jack Dorsey, Cota Capital, Celestia Capital, Mayfield Fund, others
Ulvetanna	▪ Ulvetanna's platform offers hardware acceleration for the next-gen blockchain and the process of generating ZK proofs, enabling users to access a cryptographic method of authentication to prove specific information without revealing the content.	▪ Founded in 2022 in SF, CA ▪ Raised $15M at $55M valuation ▪ Investors - Bain VC, Jump, Paradigm, Robot VC, others

Source: Pitchbook, Coingecko, company websites, press releases
As of December 31, 2023

Identity / Content Autenticity

WORLDCOIN	▪ Worldcoin is working to create a digital identification system called World ID–an identification that is generated using a person's iris, but has embedded features that focus on preserving that person's privacy. World ID aims to enable verification of personhood and also verify the authorship or authenticity of a piece of online content or interaction through the blockchain. This represents potential solutions for the proliferation of bots and deepfakes. So far, Worldcoin has attracted over 1.9 million sign-ups from dozens of countries.	▪ Founded in 2019 in SF, CA ▪ Raised to date $240M / Last round valuation $2.5Bn ▪ Investors – Blockchain Capital, Spark Capial, Bain Capital, Salesforce Ventures, Alphabet, Menlo Ventures, Khosla, A16z, Coinbase, Coinfund, Multicoin, others
SpruceID	▪ SpruceID - Developer of digital identity software intended to maximize efficiency by streamlining user identities and credentials. The company's software helps to store credentials safely and provides verifier tools to ensure receiving the right credentials from the right party, enabling companies to carry out trusted interactions through the creation of new identity infrastructure for the world.	▪ Founded in 2020 in NY ▪ Raised $42M / last round valuation - $249M ▪ Investors: A16z, Okta Ventures, A.Capital, Coinbase VC, Robot Ventures, Electric Capital, others
Zkaptcha	▪ zKaptcha is a Cloudflare for Web3. This is a captcha service that verifies challenges on the smart contract level to prevent spam and bots.	▪ Based in Stanford, CA ▪ Raised $6M at $25M ▪ Investors - undisclosed
orchid	▪ Orchid aims to serve a privacy-preserving role in Ethereum's Web3 stack. It is an incentivized peer-to-peer privacy network and decentralized VPN application that enables private access to the Internet. Users pay Orchid node providers in exchange for bandwidth. These providers stake Orchid tokens, OXT, to sell bandwidth on the Orchid Network. Providers receive user requests for traffic in proportion to their stake weight.	▪ Founded in 2017 in SF, CA ▪ MCap - $63M (Dec 31, 2023) ▪ Raised $43M ▪ Investors – Shima Capital, Placeholder Capital, Foundation Capital, Sequoia Capital, others

AI-based Solutions for Web3 Infrastructure

CORTEX	▪ Cortex is an open-source, peer-to-peer, decentralized blockchain that supports AI models to be uploaded and executed on a distributed network. Cortex achieves AI democratization by providing an open-source AI platform where AI models can be easily integrated into smart contracts to create AI-enhanced DApps. Cortex Virtual Machine (CVM) is a framework that allows efficient machine learning inference on the Cortex blockchain.	▪ Founded in 2022 in Singapore ▪ MCap - $95M (Dec 31, 2023) ▪ Investors – Arrington, Blockchain Capital, Huobi Capital, IOSG VC, others
AI ORAICHAIN	▪ Oraichain is a company that provides multidimensional trustworthy proofs of AI and enables secure integration with Web3. It is the world's first layer 1 of AI Oracle™. Their services include the development of a dynamic ecosystem of products within DeFi, NFTs, Identity, Collective Intelligence, Asset Tokenization, Smart Healthcare, and more.	▪ Founded in 2022 in Singapore ▪ MCap - $101M (Dec 31, 2023) ▪ Investors – DWF Labs

AI-based Web3 Security

Quantstamp	▪ Quanstamp is a developer of security monitoring software designed to detect and respond to suspicious activity in the blockchain. The company's software conducts smart contract, off-chain, networking, and front-end audits in order to enhance the security of a decentralized application, enabling users to have a strict auditing process on their blockchain implementation to prepare it for launch and future iterations. Quanstamp's AI products can be used to review code, identify weak spots and vulnerabilities, and prevent potential exploits and hacks.	▪ Founded in SF, CA in 2017 ▪ Raised $148M / last round valuation - $1.1Bn ▪ Investors – Translink Capital, Softbank, Dragonfly, others
CERTIK	▪ CertiK is a developer of a verification technology designed to protect and monitor blockchain protocols and smart contracts. The company's technology utilizes artificial intelligence and leverages on-chain and off-chain data in blockchain security including social sentiment, privileged governance controls, market volatility, and suspicious transactions, providing clients with real-time insights into the security of DeFi and other mission-critical applications to scale with safety and correctness.	▪ Headquartered in NY ▪ Raised to date $300M / last round valuation - $2Bn ▪ Investors - Insight Partners, Lightspeed, Softbank, Sequoia, Coatue, Goldman Sachs, others

Source: Pitchbook, Coingecko, company websites, press releases
As of December 31, 2023

ANCHAIN.AI	▪ AnChain.AI specializes in Web3 security, offering cutting-edge tools powered by artificial intelligence to enhance investigations, identify vulnerabilities, and protect your digital assets.	▪ Founded in 2018 in Milpitas, CA ▪ Raised $14M to date/ last val – $40M ▪ Investors - Susquehanna, Amino Capital, Hard Yaka, Fin Capital, others
TestMachine	▪ TestMachine develops an auditing platform intended for blockchain security. The company offers artificial intelligence for blockchain security to find and fix the vulnerabilities in smart contracts and applications for blockchain, enabling risk-free transactions on the crypto level and secure audits.	▪ Founded in 2022 in Ann Arbor, MI ▪ Investors – Delphi Digital, Decasonic

AI-based Crypto Financial Services

SPECTRAL	▪ Spectral developed a liquidity aggregation platform designed to decentralize the finance industry. The company's platform includes an on-chain credit scoring system and a novel collateral subsidization model, enabling users to identify a protocol for programmable creditworthiness. Spectral's on-chain credit score, the MACRO Score is generated from a wallet's on-chain data and a sophisticated and constantly evolving machine learning model.	▪ Founded in 2020 in New Rochelle, NY ▪ Raised $30M to date / last round valuation $230M ▪ Investors – Circle VC, Foundation Capital, Franklin Templeton, General Catalyst, Galaxy, Gradient VC, Samsung NEXT, ParaFi, Polychain
NUMERAI	▪ Numerai is building a blockchain based hedge fund that utilizes artificial intelligence and crowdsourced stock market predictions. The platform relies on a monthly machine learning and data science "tournament" where users, primarily data scientists, can submit trading algorithms about the stock market.	▪ Founded in 2015 ▪ MCap - $101M (Nov 20, 2023)
Lyra	▪ Lyra finance is an options protocol AMM with intelligent features. Lyra is a company that provides a decentralized options liquidity platform. Users can trade, earn, participate in airdrops, and vote on the platform. Lyra V2 is a forthcoming update to the platform. The interface is compatible with Ethereum and offers simple and advanced trading options. Users can buy and sell call and put options with various expiration dates and strikes.	▪ Founded in 2021 in Sydney Australia ▪ Raised $5.6M to date ▪ MCap – $75M (Dec 31, 2023) ▪ Investors – Framework Ventures, Alliance DAO, GSR, Robot Ventures, Parafi Capital.

AI-based Blockchain Gaming And Metaverse

inworld	▪ Inworld AI - is the leading Character Engine for AI NPCs. Inworld NPCs exhibit complex and lifelike behaviors, increasing player engagement and immersion. Inworld claims to use "multiple" machine learning models to "mimic the full range of human communication."	▪ Founded in 2021 in Mountain View, CA ▪ Raised to date $120M/ last round valuation $515M ▪ Investors – Lightspeed, Samsung NEXT, Founders Fund, Disney, Intel, Kleiner Perkins, M12, Meta, others
alethea.ai Trusted Synthetic Media	▪ Alethea AI is a decentralized protocol powering a growing metaverse (named Noah's Ark) of Intelligent and Interactive NFTs (iNFT). The aim of Noah's Ark is to one day be used to preserve, and even evolve, the collective intelligence of humanity. The iNFT standard, open to developers, leverages advanced technologies, including AI-powered animation, interactivity, and generation.	▪ Founded in 2019 ▪ Raised $16M / last round valuation - $116M ▪ Investors – Gemini, Multicoin, Red Beard VC, Binance Labs, Griffin Gaming, Bitkraft, Galaxy, Sfermion, 6th Man VC, others
asm	▪ ASM is a developer of artificial intelligence-based blockchain software designed to provide developers and NFT owners a decentralized platform that allows users to interact with AI Agents across gaming worlds, financial applications, and metaverses, create, train, and own nonfungible intelligence, enabling players to develop and own their digital assets.	▪ Founded in 2021 in Auckland, NZ ▪ Investors – Shima, Polygon, Outlier VC, Delphi Digital, The Chernin Group, Warner Music, GoldenTree, Coinbase VC, Animoca, 6th Man VC
PLAI LABS <PLAY WITH AI>	▪ PLAI Labs is focused on building the next generation of social platforms leveraging AI and Web3. Their first experience is Champions Ascension, a multiplayer online role-playing game where players can port in their existing NFTs characters, go on quests, trade items, etc. They're also building an AI protocol platform that will help with everything from user-generated content to matchmaking to 2D to 3D asset rendering.	▪ Founded in 2023 in Culver City, CA ▪ Raised $32M ▪ Investors – A16z, Coinbase VC, Crush Ventures, UTA Ventures

Source: Pitchbook, Coingecko, company websites, press releases
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AI ARENA	▪ AI Arena is a web P2E fighting game in which players design, train, and battle AI-powered NFTs in a global arena competition. The aim is to become the top AI Arena Master and secure valuable prizes.	▪ Founded in 2021 in Toronto, Canada ▪ Raised $5M to date ▪ Investors – SevenX Ventures, Paradigm, Framework VC, others
MAWARI	▪ Mawari is a decentralized XR content delivery platform. Mawari provides an AR-focused streaming SDK that renders 3D content in the cloud and delivers it efficiently to devices. Core to the AR Streaming SDK is Mawari's unique, patent-pending compression technology that minimizes the weight of 3D content and enables real-time rendering and streaming to smartphones and AR glasses.	▪ Founded in Los Altos, CA in 2017 ▪ Raised to date $9.5M/ last round valuation - $20M ▪ Investors – Outlier Ventures, Decasonic, others

Decentralized Physical Infrastructure Networks

NOVA	▪ **Nova Labs (Helium)** is a decentralized blockchain-powered network for Internet of Things (IoT) devices. The company's technology operates a peer-to-peer wireless network that provides a secure and cost-effective way to send data, providing businesses with a decentralized model for building wireless infrastructure.	▪ Mcap - $1.0Bn (Dec 31, 2023) ▪ Raised to date - $250M ▪ Last round valuation – $1.33Bn ▪ Investors – A16z, Khosla Ventures, Multicoin Capital, Union Square Ventures, others.
hivemapper	▪ **Hivemapper** incentivizes individuals by offering them token rewards to install dashcams on their vehicles and gather street-level imagery to build a digital map. The company also incentivizes participants to train its ML model by providing feedback on the image content (speed limit signs and traffic lights).	▪ Raised $23M to date. ▪ Last round valuation - $88M ▪ Investors – craft ventures, Multicoin, Google Ventures, Spark Capital, Founder Collective, others.
react	▪ **The React Network** is a developer of a renewable energy platform. The company's platform rewards by giving cashback on using home energy from their battery storage systems, rooftop solar, and installations, thus transforming the electricity utility and creating a decentralized and distributed community energy network.	▪ Founded in 2020 in Austin, TX ▪ Raised $4M ▪ Investors – DCG, Lattice Capital, Lerer Hippeau, CoinShares, others
DIMO	▪ **DIMO** develops an open, connected vehicle platform that allows drivers to collect and share vehicle data. The company's mobile and fleet apps offer a vast range of data insights to drivers by streaming vehicle data and using its marketplace, thereby providing user ownership and governance of the network.	▪ Founded in 2020 ▪ MCap - $73M (Dec 31, 2023) ▪ Raised $9M / last round valuation - $76M Investors – Coinfund, Lattice, Stratos Technologies, Variant Fund, others
WEATHER XM	▪ **WeatherXM** provides weather forecasting and analytics services intended for the energy sector. The company combines weather data with proprietary sensor technology and artificial intelligence to deliver weather forecasting services, enabling customers with better weather insights needed to achieve goals.	▪ Founded in 2012 in Athens, Greece ▪ Raised $5M ▪ Investors – Borderless Capital, Consensys Mesh, Placeholder Capital, Protocol Labs, others

Source: Pitchbook, Coingecko, company websites, press releases
As of December 31, 2023