Project Truly Open AI
An open infrastructure for decentralized AI

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1. Introduction

Today, AI is in the hands of a handful of large companies in the world. While it works well enough for the current use cases, it suffers from the inherent weakness of the centralized AI systems. What is needed is a decentralized AI infrastructure, allowing anyone to publish and consume AI models trustlessly.

The primary challenge with building a decentralized AI infrastructure in the current blockchain ecosystem is the limited capability to run complex AI models due to size and computational constraints.

We propose a solution by building scalable Bitcoin L2 blockchains designed specifically for AI tasks. The AI models are stored onchain. The inference engines are programmed as smart contracts, so AI models are executed trustlessly and efficiently without the limitations imposed by traditional blockchain infrastructure.

We also shipped Eternal AI (https://eternalai.org), a reference implementation of the first AI blockchain.

2. AI Blockchains

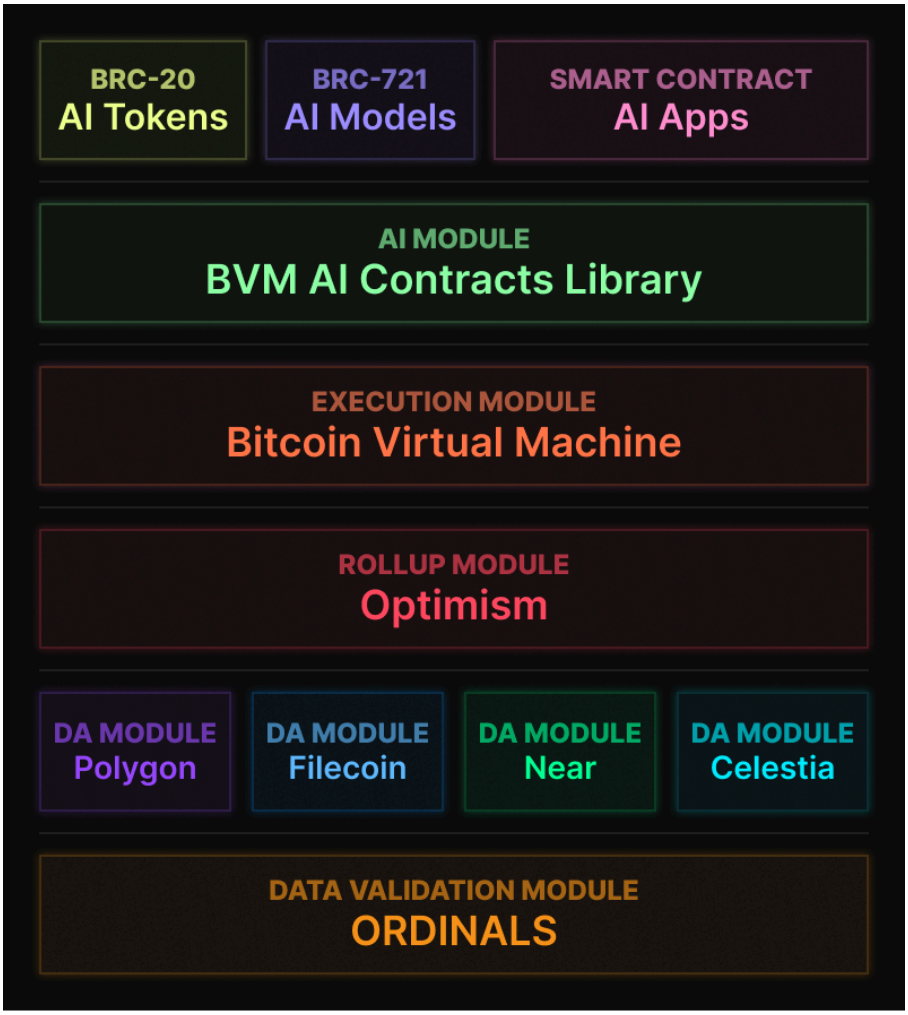
AI blockchains are Bitcoin L2 chains designed explicitly for executing AI smart contracts and storing AI models.

These AI smart contracts are AI decentralized applications that run exactly as programmed, without any risk of downtime, censorship, or interference. The AI models are stored onchain, so anyone can verify which models are being used without being tricked.

These AI blockchains facilitate secure, reliable, and decentralized environments for leveraging advanced AI capabilities, ensuring that these powerful tools are accessible to all.

3. Blockchain Architecture

AI blockchains are powered by Bitcoin Virtual Machine (BVM). They are modular Bitcoin L2 blockchains built specifically for AI. BVM is EVM-compatible and the AI code is written in Solidity. For the first time, developers can integrate AI functionalities to their dapps.



AI Blockchain Architecture

Data Validation Module: Bitcoin

At the core of this architecture lies the Data Validation Component, which establishes a secure, reliable, and decentralized foundation for the entire stack. This pivotal component is the bedrock from which all other elements of the stack are developed.

Data Availability Module: Near, Filecoin, Polygon and Avail

Instead of storing everything on Bitcoin, we only store the transaction hash on Bitcoin while the actual data is housed on alternative Data Availability (DA) platforms, including Near, Filecoin, Polygon, and Avail[1]. While it is argurable that this is not 100% pure Bitcoin, it is a pragmatic solution. We leverage Bitcoin's unparalleled security and highly cost-efficient DA platforms, ensuring an optimal balance between security and economy.

- Filecoin, for example, provides a robust decentralized storage solution, perfectly suited for the voluminous data requirements of large AI model smart contracts. Its architecture is built for maximum redundancy and security, ensuring data integrity and availability. The innovative incentive model of Filecoin guarantees dependable data storage across a vast network of global computers, offering a cost-effective alternative to conventional cloud storage services while improving data accessibility.

- Near stands out as an ideal platform for housing large AI models within smart contracts, thanks to its remarkable scalability and affordability. This is largely attributed to its sophisticated sharding technology, which allows for the efficient handling of expansive datasets at reduced transaction costs, making it a go-to choice for AI-driven applications seeking robust scalability without the burden of high expenses.

- Polygon stands out for its stability and widespread use, though it comes at a slightly higher cost compared to alternatives. While it has smaller-size transactions, BVM did a great job segmenting it, ensuring smooth I/O operations on this DA platform.

By leveraging the DA hotswap feature of BVM, AI blockchains can enhance the efficiency of utilizing multiple DA platforms. This approach not only reduces costs but also improves data performance and availability.

Rollup Module: Optimistic

BVM incorporate the battle-tested codebase of Optimism as a Rollup Module, enhancing the system's efficiency and scalability.

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[1] As of this writing, Avail is only available on the testnet.

Virtual Machine Module: EVM

BVM is EVM-compatible, meaning it enables developers to embed neural network capabilities within their smart contracts using Solidity. It facilitates a faster route to market for developers by providing access to extensively tested smart contract libraries dedicated to AI.

AI Module: BVM AI Contracts Library

The AI Module provides the requisite infrastructure and tools essential for deploying models and conducting effective on-chain inference with these models.

4. BVM AI Contracts Library

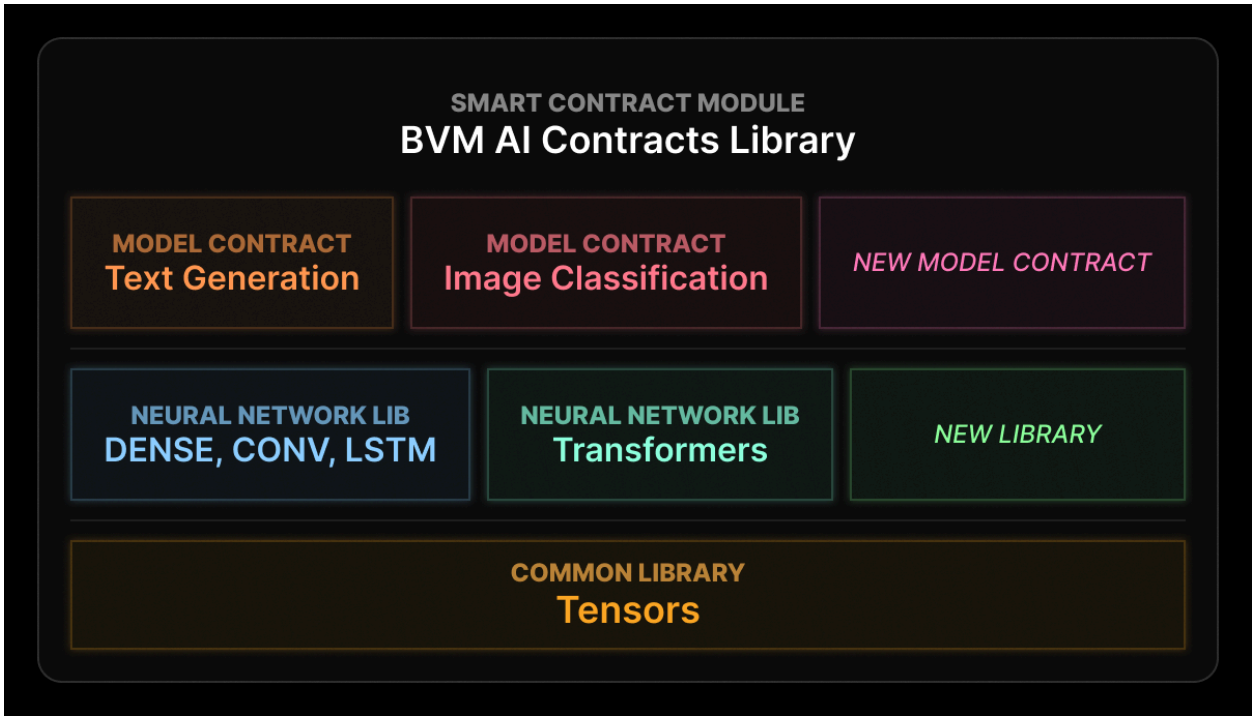
Let’s deep dive into the BVM AI Contracts Library.

Its architecture is inherently flexible, designed to accommodate expansion through the addition of modules that support various neural network architectures. This enables builders to craft decentralized applications (dApps) leveraging pre-deployed models for enhanced functionality.

Furthermore, it empowers them to deploy their unique models via the platform's smart contracts, or even to innovate further by crafting new contracts tailored to different model tasks.

The library is structured into three distinct layers:

- At the apex, the model contract layer is responsible for managing specific machine learning tasks.
- The intermediary layer is dedicated to implementing the intricate computations associated with various neural network layers.
- Lastly, the foundational layer focuses on executing tensor computations.



Model Contract

Model smart contracts are in charge of carrying out specific machine learning operations. While they can perform various tasks, they share three standard functions.

Set up model config

```
function setModel(
uint256 modelId,
bytes[] calldata layers_config
) external
```

Upload model weights

```
function appendWeights(
uint256 modelId,
SD59x18[] memory weights,
uint256 layerInd,
LayerType layerType
) external
```

Inference or Evaluate

function evaluate(
uint256 modelId,
uint256 fromLayerIndex,
uint256 toLayerIndex,
SD59x18[][][] calldata x1,
SD59x18[] calldata x2
) external

This function facilitates layer-by-layer evaluation, allowing for a controlled approach to optimize computational complexity with each execution.

```
function forward(MaxPooling2DLayer memory layer, SD59x18[][][] memory x)
    internal pure returns (SD59x18[][][] memory) {
    Tensors.Tensor3D memory xt = Tensor3DMethods.from(x);
    Tensors.Tensor3D memory yt = xt.maxPooling2D(layer.stride, layer.size, layer.padding);
    return yt.mat;
}

function forward(Conv2DLayer memory layer, SD59x18[][][] memory x)
    internal pure returns (SD59x18[][][] memory) {
    Tensors.Tensor3D memory xt = Tensor3DMethods.from(x);
    Tensors.Tensor4D memory wt = layer.w;
    Tensors.Tensor1D memory bt = layer.b;
    Tensors.Tensor3D memory yt = xt.conv2D(wt, layer.stride, layer.padding).add(bt);
    Tensors.Tensor3D memory zt = yt.activation(layer.activation);
    return zt.mat;
}
```

5. AI Models as NFTs

We propose a solution to tokenize AI models as Non-Fungible Tokens (NFTs). This changes the landscape of AI model ownership, distribution, and commerce. This empowers creators with unparalleled control over their intellectual creations, while also enabling safe and clear transactions on the blockchain.

Each AI model, represented as a unique, authenticatable NFT, paves the way for a fresh marketplace dedicated to AI advancements. Users contribute a fee to the model's proprietor with every application, providing model owners with a dual benefit: the ability to generate revenue from their models and the option to engage in trading.

6. Conclusion

The ultimate goal of Project Truly Open AI is to democratize access to advanced AI technologies, making them available in a decentralized and secure manner. By enabling AI smart contracts on the blockchain, we aim to accelerate innovation, reduce time to market for developers, and open up new opportunities for integrating AI into decentralized applications.

This not only enhances the capabilities of smart contracts but also introduces the concept of AI composability, where AI-driven contracts can interact and combine to create more complex and intelligent decentralized applications.