Neuronet: Decentralized Proof-of-Learning based AI ecosystem

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Abstract

Neuronet is a decentralized, blockchain-based platform designed to incentivize the creation, training, and sharing of artificial intelligence models at scale. By aligning Tokenomics with real-world AI demand, Neuronet aims to sustainably foster a global marketplace for computer resources, data, and expertise.

Problem

Artificial intelligence (AI) is poised to transform industries—from healthcare and finance to transportation and entertainment. However, AI research and compute remain:

- Resource-Intensive: Training state-of-the-art models often requires vast GPU power.
- Centralized: A few cloud providers dominate compute resources, limiting decentralization.
- Costly: Pay-as-you-go cloud services are expensive, hindering small teams and independent researchers.

Neuronet addresses these challenges by creating a permissionless environment where anyone can contribute computing resources (GPUs) and stake tokens to earn rewards while supporting AI training. The reward mechanism optimally balances supply (compute nodes) with demand (training jobs) through Proof-of-Learning (PoL) principles.

2. High-Level Overview

Neuronet merges elements of staking (common in proof-of-stake blockchains) with AI training demands. Key functionalities include:

1. Staking: Users lock their tokens to secure the network and earn passive yields.
2. Compute Provision: Participants with GPU resources run AI training jobs and earn additional rewards based on performance.
3. Marketplace: Researchers and enterprises submit AI tasks, paying in tokens for compute power.

4. Governance: Token holders vote on protocol improvements (e.g., reward distribution, inflation parameters).

By tying rewards to AI demand, GPU node power, and total staking, the system dynamically adjusts payouts as usage grows or competition changes.

3. Ecosystem Participants

Stakers

Individuals or entities that lock their tokens in a smart contract to support network security and governance. In return, they receive a portion of the overall token issuance known as Staking Yield (APY).

GPU Node Operators

These are participants who provide compute resources (GPUs) to train AI models on the network. Rewards come from two sources:

1. User Fees: Researchers pay for training jobs.
2. Protocol Rewards: Additional tokens minted or allocated from the protocol's reward pool.

Researchers / AI Demand Side

Companies, research labs, or individual developers who submit AI training tasks. They pay in tokens for the computational resources consumed. They benefit from:

- Competitive Pricing: Decentralized GPU marketplace often lowers costs.
- Scalability: Access a global pool of GPU nodes.
- Trustless Execution: Transparent, on-chain settlement ensures fair resource allocation.

Governance & Development Teams

- Governance: Token holders collectively propose and vote on updates to parameters such as inflation rate, reward distribution, or improvements to the training frameworks.
- Core Development Team: Maintains the platform's base code, ensures network stability, and provides documentation for new participants.

4. Tokenomics & Reward Distribution

Neuronet's Tokenomics revolve around two key reward models:

Staking Yield Model

$$Y = \frac{T_r}{S_t} \times \frac{D_{ai} \times C_g}{N_n}$$

Where:

- Y = APY % (Annual Percentage Yield) for stakers
- Tr = Total rewards allocated to staking
- St = Total staked supply
- D{ai} = AI computation demand (training jobs requiring execution)
- Cg = Compute power per node (adjusted for efficiency)
- Nn = Number of active compute nodes

Interpretation:

- Higher AI Demand leads to higher yield.
- Greater GPU Power boosts overall yield.
- More Compute Nodes reduces yield per node (competition).
- Increased Staked Tokens dilutes yield per staker.

GPU Reward Model

$$R_{gpu} = \frac{D_{ai} \times C_g}{N_n} \times \frac{S_t}{T_s}$$

Where:

- R{gpu} = Reward per training node
- St = Staked supply
- Ts = Total token supply (introducing scarcity effects over time)

Interpretation:

- Higher AI Demand = Higher GPU rewards.
- More powerful GPUs = Higher rewards.
- More nodes = Lower rewards per node.
- Greater Staked Supply = Higher GPU rewards.
- Larger Total Token Supply = Lower GPU rewards (dilution).

Emission & Inflation

uses a smooth or demand-responsive emission schedule:

- Targeting a certain inflation rate, adjusting issuance based on AI demand.
- Preventing runaway inflation by capping issuance or gradually reducing the maximum reward pool over time.

Economic Balance

The system self-balances by aligning GPU rewards with staked tokens and real demand. If AI training volume spikes, more tokens flow to GPU node operators, incentivizing additional compute. As more nodes join, rewards per node diminish, preventing oversupply. Staking yield remains sensitive to both total staked supply and the current level of AI demand.

Potential Token Distribution for long-term Growth and Dynamic Reward Scaling

Staking Rewards Pool (20%)

GPU Operator Rewards Pool (30%)

Public / Market Allocation (20%)

Team & Dev (15%)

Ecosystem / Treasury (10%)

Reserve / Strategic Partnerships (5%)

Sustainable environment Phases:

High Efficiency phase:

Less training may be required, leading to diminishing returns on learning.

Nuance- Adoption phase may arrive after achieving 'high-efficiency'. Models may be fine-tuned for specialized use cases. Nonetheless, incremental learning will always be abundant on the network since users participating will continue usage of model.

Low Demand phase:

Governance can vote on updating the fee-based incentives. Fewer tasks and usage require lower gas fees to function. Also, using DAO to tweak parameters during low demand phases, such as staker compensation and leftover inflation shifts.

Sustainability Longer term:

Ensuring sustainability would require adaptive inflation: - minting is dynamically scaled to match demand and reward emissions. Over time, after training the model to a sufficient performance level, a gradual shift towards fee-based structure is required. Hence user fee becomes the dominant reward structure while reducing reliance on minting new supply. (NEAR-LIMITED SUPPLY) and therefore APY will adjust according to the user fee generated against gas fees and other network costs. Additionally, governance and reputation systems will sustain nodes to keep running tasks. Verified nodes receive reputation boosts to increase trust.

5. Knowledge Sharing Framework

One core tenet of Neuronet is collective intelligence:

1. Shared Model Insights: Node operators share partial model updates (anonymously or securely) to highlight best practices in training. Working in an ecosystem to create a consensus based artificial neuron.
2. Open Documentation: Community-driven documentation ensures new participants adopt optimal methods.
3. Governance Transparency: All proposals, performance metrics, and usage data are publicly accessible, building trust and enabling informed decision-making.

This knowledge sharing creates a powerful feedback loop: better-trained models attract more researchers, driving AI demand, which boosts rewards and leads to more computing.

6. Governance Model

Neuronet employs on-chain governance, giving token holders direct influence:

1. Proposal Submission: Anyone can submit proposals (e.g., to tweak reward parameters, adopt new AI frameworks, or adjust governance rules).
2. Voting Process: Stakers and GPU node operators with reputational weighting vote on proposals.
3. Implementation: Successful proposals are either automatically enforced by smart contracts or implemented by the core team.

DAO-Like Structures

As the network matures, it evolves into a Decentralized Autonomous Organization (DAO), featuring:

- Community-elected committees.
- Project funding for research or new AI tools.
- Grant pools encouraging open-source contributions.

7. Implementation Details

Smart Contracts

Neuronet's chain of layer-2 solution hosts smart contracts handling: (could use oracles)

- Staking & Unstaking: Manages locked tokens and yields.
- GPU Reward Calculation: Pays out node operators based on their validated training contributions.
- Governance & Voting: Facilitates proposals, tallies votes, and enacts changes.

Protocol Layers

1. Core Protocol Layer: Defines the token standards, staking logic, and GPU computation reward distribution.
2. Compute Orchestration Layer: Interacts with **GPU nodes off-chain**, **distributing** tasks and collecting updates. It then reports back the results for reward calculation.
3. Storage & Data Access: Can integrate decentralized storage solutions (like **IPFS** or specialized networks) to share training datasets and model artifacts.

Security & Validation

- Proof-of-Learning: Mechanisms ensure tasks are completed correctly. Nodes submit cryptographic proofs or partial training checkpoints to claim rewards.
- Slashing Conditions: Dishonest or underperforming nodes risk losing staked collateral.
- Auditing: Smart contracts regularly undergo audits to prevent bugs or exploits.

9. Potential Use Cases

- Academic Research: Universities or labs can train large models collaboratively, sharing GPU resources.
- Enterprise AI: Companies scale compute tasks without relying on a single cloud provider.
- Edge Compute: IoT devices or small data centers can pool resources for specialized AI tasks.
- Federated Learning: Multiple parties train a shared model without exchanging sensitive data.

SUMMARY a comparison to Bitcoin

1. Computation Focus
    - Bitcoin: Hashing for security.

- Neuronet: Machine learning tasks that generate tangible AI model improvements based on cryptographic proofs and peer-to-peer assessment of learning metrics.

2. Economic Models
    - Bitcoin: Emphasizes fixed supply, halving schedule, eventual reliance on transaction fees.
    - Neuronet: Could also have a cap but use a dynamic decaying issuance + fee-based model, governed by dynamic demand for AI and governance model.
3. Usefulness of Work
    - Bitcoin: The “usefulness” is primarily network security and immutability for store of value.
    - Neuronet: Secures the network *and* trains real AI models, delivering external value (e.g., better text generation, image recognition). Collaborative effort to improve the AI model. Essentially creating an ecosystem-driven based AI model.
4. Long-Term Vision
    - Bitcoin: Digital store of value, backbone for trust-minimized transactions.
    - Neuronet: A marketplace and ecosystem for decentralized AI, fueling innovation by rewarding GPU compute with direct AI benefits. Mass adoption and advanced reasoning models lead to a completely decentralized consensus-based approach towards machine learning.

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