# A Novel Approach for Predictable Governance of Decentralized Autonomous Organizations based on Parallel Intelligence


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## Introduction

The rapid evolution of digital technologies has transformed traditional organizational structures. Decentralized Autonomous Organizations (DAOs) have emerged as a novel self-governing economic model, integrating blockchain, smart contracts, and decentralized governance mechanisms. DAOs fundamentally reshape corporate governance by:

- Unifying ownership and management through group decision-making models.
- Adopting dynamic, distributed structures that evolve within decentralized networks.
- Replacing traditional control mechanisms with rule-based smart contracts.

DAOs are expanding beyond the crypto industry, integrating with real-world governance models, legal structures, and funding mechanisms. However, despite their potential, DAOs face significant governance challenges, including contract risks, principal-agent dilemmas, and security vulnerabilities. Existing governance models fail to address DAOs' complexity, necessitating new approaches. This research aims to address these challenges through the following objectives:

1. **Propose a Parallel Governance Framework**
   - Develop a governance approach based on *parallel intelligence theory* (ACP method: artificial systems, computational experiments, parallel execution).
   - Define its technical methodology and implementation model.
2. **Validate Through Computational Experiments**
   - Implement the framework in *GnosisDAO* to assess its effectiveness.
   - Analyze governance flaws and demonstrate *parallel governance* as a viable solution for DAOs.

## Parallel DAO Governance

**General Framework** The Parallel Governance Framework applies Parallel Intelligence Theory (ACP Method) to DAO governance, integrating:

- **Artificial Systems (A)** – Simulated DAOs for governance modeling.
- **Computational Experiments (C)** – Simulations to test governance strategies.
- **Parallel Execution (P)** – Real-time governance optimization.

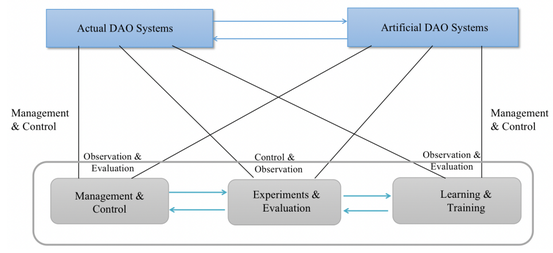


**Figure 1:** A Parallel Governance Framework for DAOs

**Basic Model**
Parallel governance optimizes DAO decision-making by modeling interactions between the actual system and artificial system. Let $S, S'$ be the state spaces of the actual and artificial DAO systems, where:

$$s_i = f(a_i), \quad a_j = \Pi(s_j), \quad i, j = 0, 1, 2, \ldots \tag{1}$$

Here, $f$ describes how actions induce state changes, and $\Pi$ represents governance decision-making.
Governance risk is quantified as:

$$E = \sum_i P_i \cdot I_i \tag{2}$$

where $P_i$ represents risk probability, and $I_i$ denotes potential loss.

The objective of parallel governance is to minimize governance risk:

$$\min_{a \in A} E(f, \Pi) \tag{3}$$

where $a$ represents governance actions such as adjusting system parameters and optimizing mechanisms.

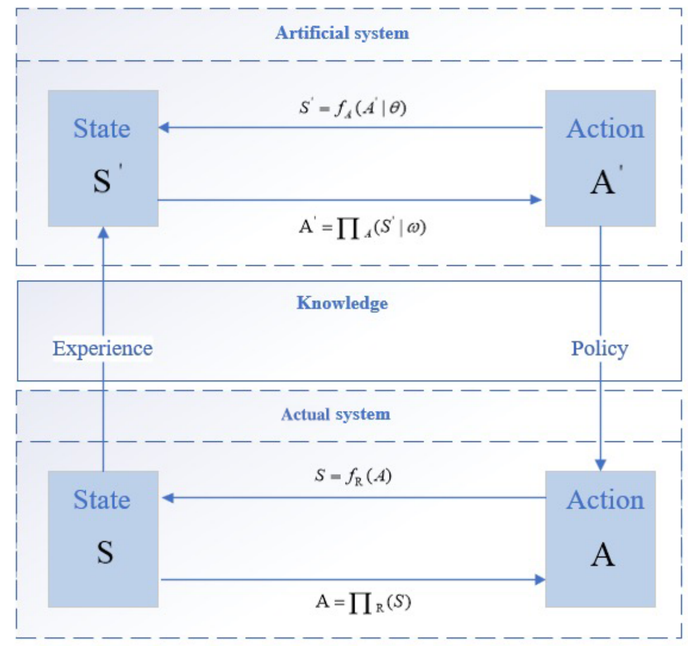


**Figure 2:** Mathematical Model of Parallel Governance

## Case Study: GnosisDAO

To evaluate the applicability of the Parallel Governance Framework, we implement it in GnosisDAO, a decentralized platform utilizing the futarchy mechanism for governance. An artificial GnosisDAO system is constructed, initialized with real-world DAO data, and examined through computational experiments to analyze governance dynamics and identify potential risks.

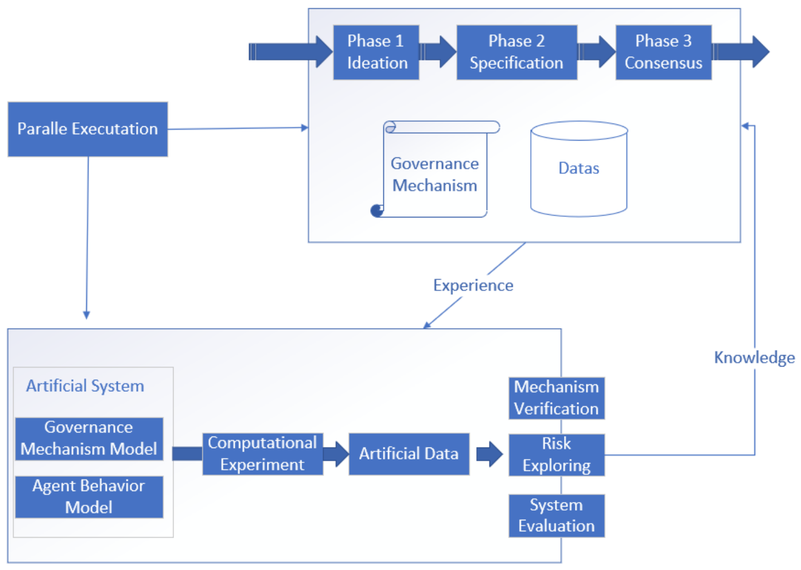


**Figure 3:** Structure of the Experiment

**GnosisDAO Governance Mechanism**

- **Ideation & Specification** – Off-chain discussions in community forums.
- **Consensus** – On-chain futarchy mechanism selects optimal proposals via prediction markets and voting.

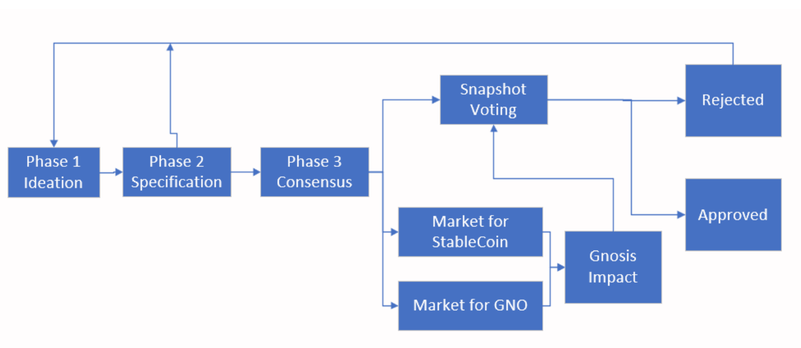


**Figure 4:** GnosisDAO Governance Flow

**Agent-Based Simulation**
Model GnosisDAO as a multi-agent system where agents trade and vote based on beliefs. The futarchy mechanism encourages agents to gather and act on information.
**Belief Update Model:**

$$b_{n,e,d} = u_{n,e,d} \cdot b_{n,e,d-1} + (1 - u_{n,e,d}) \cdot \pi_{e,d} \tag{4}$$

where $b_{n,e,d}$ is the agent's belief on proposal $e$, updated based on system price changes.
**Governance Loss Function:**
Governance effectiveness is measured by:

$$E = Loss_1 + Loss_2 \tag{5}$$

where:

- $Loss_1$ – Information-collecting agents should gain economic advantages.
- $Loss_2$ – Market predictions should align with actual voting outcomes.

| Address | Choice | Balance | Day | Timestamp | DateUtc |
|---|---|---|---|---|---|
| 0xd714Dd60e22BbB1cbAFD0e40dE5Cfa7bBDD3F3C8 | 1 | 1 | 0 | 1606153944 | Mon, 23 Nov 2020 17:52:24 GMT |
| 0x03118e02cE007a0F0d1C9D806c2a7D5Ae2F26995 | 1 | 12 | 0 | 1606154547 | Mon, 23 Nov 2020 18:02:27 GMT |
| 0x236Ff34518dBa76612BB571A7bAA6201D02Ea985 | 1 | 2.16448559 | 0 | 1606158835 | Mon, 23 Nov 2020 19:13:55 GMT |
| 0xFC56b02eDCd54cB7f88134c4218caB8A530FBF44 | 1 | 2430.22 | 0 | 1606162223 | Mon, 23 Nov 2020 20:10:23 GMT |
| 0x7B4F11f64DA52ce0A8f7Bcfc776BC50FC94aAca0 | 1 | 1582.031814 | 0 | 1606163105 | Mon, 23 Nov 2020 20:25:05 GMT |
| 0x11B1785D9Ac81480c03210e89F1508c8c115888E | 1 | 1.02 | 0 | 1606170996 | Mon, 23 Nov 2020 22:36:36 GMT |
| 0x06b172c63730F0cCFb40ea35E726ebF4E930c9e3 | 1 | 54.08243398 | 0 | 1606173115 | Mon, 23 Nov 2020 23:11:55 GMT |
| 0x1861974f32eaCDCceD0F81b0f8eCcFeD58153a9D | 1 | 11.20709689 | 1 | 1606181100 | Tue, 24 Nov 2020 01:25:00 GMT |
| 0xa291017D892E62b5Ed74cEA8D38D9CB00a583343 | 1 | 1.068534371 | 1 | 1606200149 | Tue, 24 Nov 2020 06:42:29 GMT |
| 0xed0C647095c52d21857932d49e414f9fc4dc759D | 1 | 1 | 1 | 1606200270 | Tue, 24 Nov 2020 06:44:30 GMT |
| 0x009Ec7D76feBECAbd5c73CB13f6d0FB83e45D450 | 1 | 15.54542954 | 1 | 1606209525 | Tue, 24 Nov 2020 09:18:45 GMT |
| 0x14e9e9F0A8D9bAc4CaD8c1CE339826f42924E542 | 1 | 24889.95892 | 1 | 1606209548 | Tue, 24 Nov 2020 09:19:08 GMT |
| 0xBa45B15E1349B6405e43B70fe18C112f1feC7f59 | 1 | 2451.93 | 1 | 1606211605 | Tue, 24 Nov 2020 09:53:25 GMT |
| 0x7B2e78D4dFaABA045A167a70dA285E30E8FcA196 | 1 | 1.552456452 | 1 | 1606211692 | Tue, 24 Nov 2020 09:54:52 GMT |
| 0x64E482233Ca8bbFCd7fBCc670808fa0eB09c5cc3 | 1 | 1.905148504 | 1 | 1606211720 | Tue, 24 Nov 2020 09:55:20 GMT |
| 0x6119Fa6C5B18BE03F3b8E408c961E28239A0108C | 1 | 152.7488328 | 1 | 1606213519 | Tue, 24 Nov 2020 10:25:19 GMT |
| 0x16c5EFd522b2fDBa7342f13e4dC65681Ff674f0d | 1 | 2374.845 | 1 | 1606219566 | Tue, 24 Nov 2020 12:06:06 GMT |
| 0x3FBB1742C5364239164b8bEF4c386F38ceBa80D3 | 1 | 17.34282 | 1 | 1606220073 | Tue, 24 Nov 2020 12:14:33 GMT |
| 0x865c2F85C9fEa1C6Ac7F53de07554D68cB92eD88 | 1 | 15.42421883 | 1 | 1606221670 | Tue, 24 Nov 2020 12:41:10 GMT |
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| 0x8d07D225a769b7Af3A923481E1FdF49180e6A265 | 2 | 5 | 1 | 1606230939 | Tue, 24 Nov 2020 15:15:39 GMT |

**Figure 5:** Historical Voting Data (GIP 1 and GIP 3)

**Risk Analysis and Verification**
Computational experiments were conducted with varying proportions of information-collecting agents. The results show:

- When fewer agents actively gather information, governance fails.
- A minimum 20% informed agents is required for the futarchy mechanism to function properly.

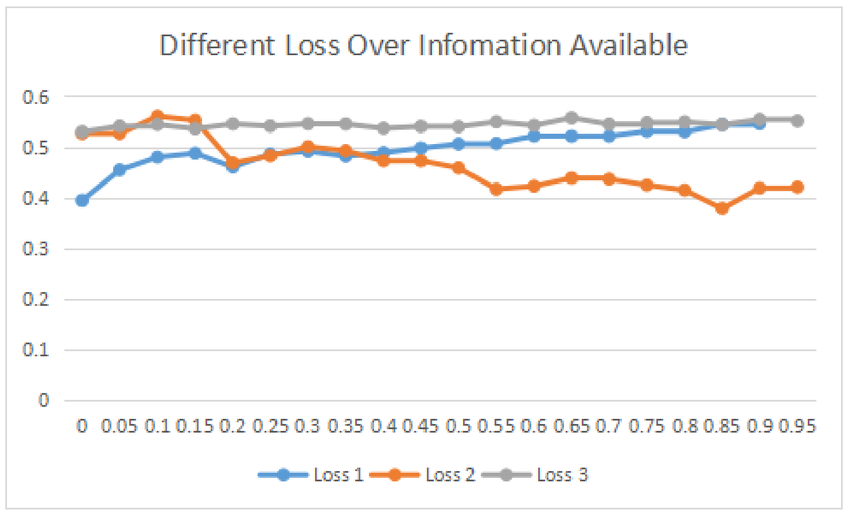


**Figure 6:** Governance Effectiveness vs. Information-Collecting Agents

**Key Findings**

- Parallel Governance enables risk detection – Experimentation in artificial DAOs exposes governance flaws.
- DAO governance relies on informed participants – If too few agents actively seek information, decision-making degrades.
- Futarchy requires a critical mass of informed voters – A threshold of 20% ensures governance effectiveness.

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## Conclusion and Future Research

DAOs, as emerging digital collaboration models, face governance challenges that traditional theories struggle to address. Research on DAO governance remains limited, lacking strong theoretical foundations. This study proposes a Parallel Governance Framework, develops its technical methodology and basic model, and validates it through computational experiments on GnosisDAO. Results indicate that the effectiveness of its futarchy mechanism depends on the proportion of informed participants.

Future work will focus on:

- **Expanding Case Studies** – Applying parallel governance to various DAOs.
- **Enhancing Agent Modeling** – Incorporating social dynamics.
- **Refining Governance Metrics** – Improving system vitality assessment and risk prediction.

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