

Composable Finance with Generative AI: Future of Decentralized Asset Management

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Abstract

The fusion of composable finance and generative AI signals a transformative leap in decentralized asset management. Composable finance, grounded in modular and interoperable Decentralized Finance (DeFi) protocols, allows developers and users to assemble, customize and automate financial services using plug-and-play smart contract components. Generative AI, leveraging advanced architectures like transformers and diffusion models, introduces new possibilities for dynamic portfolio generation, synthetic asset creation and predictive market analysis.

This paper presents an integrated view of how generative AI can enhance composability by intelligently automating decision pathways, risk profiling and liquidity routing across blockchain ecosystems. Drawing insights from Finance 4.0 innovations, AI-powered automation in financial infrastructure and the design of secure, data-driven DeFi environments, we explore use cases that redefine user interaction and asset control in decentralized settings.

The research proposes a reference architecture where generative agents act as co-creators of financial strategies, supporting autonomous rebalancing and compliance monitoring in real time. We also analyze how Decentralized Autonomous Organizations (DAOs) can integrate AI agents for governance optimization and crowd-sourced financial intelligence. Challenges such as model transparency, tokenomics, adversarial manipulation and explainability are examined in depth.

The paper outlines a future-forward blueprint for scalable, AI-augmented composable finance platforms that reduce technical complexity, increase inclusivity and align with the core tenets of decentralization, user sovereignty and verifiable execution in the Web3 era.

Keywords: Composable finance; Generative AI; Decentralized Finance (DeFi); Decentralized asset management; Smart contracts; Decentralized Autonomous Organizations (DAOs); Federated learning; Blockchain integration; Risk profiling; Synthetic asset creation

Introduction

Decentralized Finance (DeFi) has emerged as one of the most disruptive innovations in the financial landscape, enabling permissionless access to financial instruments through blockchain technology. Within this evolving ecosystem, composable finance the ability to assemble and reassemble DeFi protocols like building blocks offers a paradigm shift in how financial services are built, consumed and scaled. However, as DeFi matures, the complexity of managing digital assets, evaluating risk and maintaining

portfolio diversification continues to grow, demanding intelligent, adaptive solutions [1-5].

Generative Artificial Intelligence (AI), originally popularized through its applications in content creation and natural language processing, now presents new opportunities in financial automation and decision-making [6]. Unlike traditional rule-based AI systems, generative AI models can synthesize new data, predict dynamic scenarios and

autonomously design financial strategies. The convergence of generative AI with composable finance holds the potential to democratize decentralized asset management, allowing users to co-create, personalize and deploy financial tools with minimal technical friction.

This paper explores how generative AI can augment the core tenets of composable finance by offering real-time adaptive intelligence, user-specific strategy generation and automated compliance mechanisms [7]. It also investigates how such integration can reduce cognitive overhead for users, optimize protocol interoperability and support sustainable growth in decentralized markets.

Objectives of the paper

The primary objectives of this paper are as follows:

- To define and contextualize composable finance within the broader DeFi ecosystem, highlighting its modularity and integration challenges.
- To examine the capabilities of generative AI models in constructing, optimizing and monitoring decentralized asset management strategies.
- To present a system architecture that leverages generative agents for automated portfolio assembly, synthetic asset creation and cross-protocol liquidity routing.
- To analyze use cases and implementation frameworks that showcase real-world applicability across lending, derivatives and tokenized asset markets.
- To address key limitations related to transparency, explainability, governance and security in the fusion of generative AI and decentralized finance.
- To propose a forward-looking blueprint for scalable, AI-augmented DeFi platforms that are trustless, composable and user-centric.

By combining recent advancements in neural network-based AI and decentralized governance, this paper aims to illustrate a future wherein financial participation is not only open and borderless but also intelligent and adaptive to each user's evolving goals and market conditions.

Literature Review

The convergence of composable finance and generative AI presents a disruptive paradigm for decentralized asset management. Recent academic and industrial literature has begun to explore the synergies between these domains, emphasizing the modularity, automation and intelligence that define the next generation of financial services.

Composable finance refers to the principle of building financial applications like interoperable "money legos," where

decentralized protocols can be stacked and integrated [8,9]. This architecture allows developers and investors to compose complex financial instruments from simpler, reusable components. Literature on Decentralized Finance (DeFi) highlights the growing traction of composable protocols such as lending, insurance and derivatives that interact permissionlessly.

Generative AI, meanwhile, is transforming decision-making through autonomous content and strategy generation [10,11]. In financial applications, generative models are being deployed for scenario modeling, portfolio optimization, predictive analytics and synthetic data generation. The literature shows a clear shift from traditional rule-based financial analytics to probabilistic, neural network-based systems that learn from historical data and simulate future outcomes.

Researchers have explored how AI-enhanced automation increases capital efficiency in decentralized exchanges and autonomous hedge funds [12]. Additionally, the application of Large Language Models (LLMs) is being investigated for use in autonomous financial agents, capable of parsing real-time financial reports and dynamically rebalancing assets [13].

The integration of blockchain infrastructure ensures transparency, traceability and security in generative AI applications, mitigating risks like hallucinations, tampering or data leakage [14]. Several studies explore how tokenized governance, smart contracts and zero-knowledge proofs can be employed for verifiable AI actions within composable financial systems.

Scholars have also addressed risk and compliance challenges, particularly the necessity for explainability in AI-generated decisions within high-stakes finance. There is a focus on incorporating regulatory constraints and risk heuristics into generative frameworks, especially in lending and insurance ecosystems [15] (Figure 1).

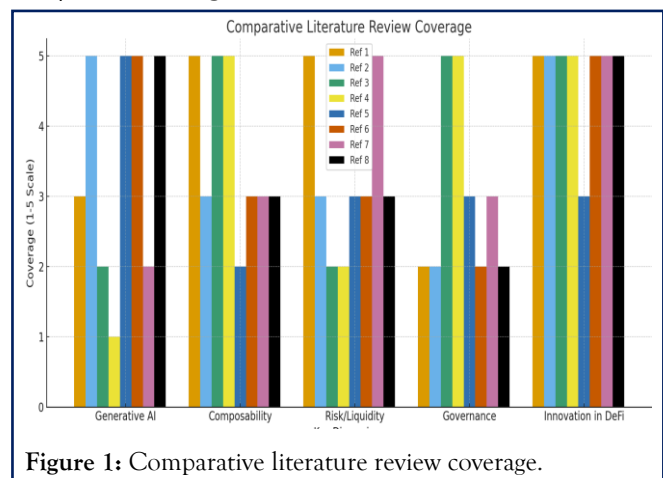


Figure 1: Comparative literature review coverage.

Materials and Methods

Overview

The proposed methodology integrates composable Decentralized Finance (DeFi) protocols with generative artificial intelligence (GenAI) models to develop a modular, intelligent asset management framework [17,18]. The architecture supports dynamic portfolio construction, real-time risk modeling and adaptive strategy optimization, leveraging smart contracts, tokenized governance and AI-driven predictions.

This section outlines the system architecture, dataset description, model usage strategy and performance evaluation metrics [19] (Figure 2).

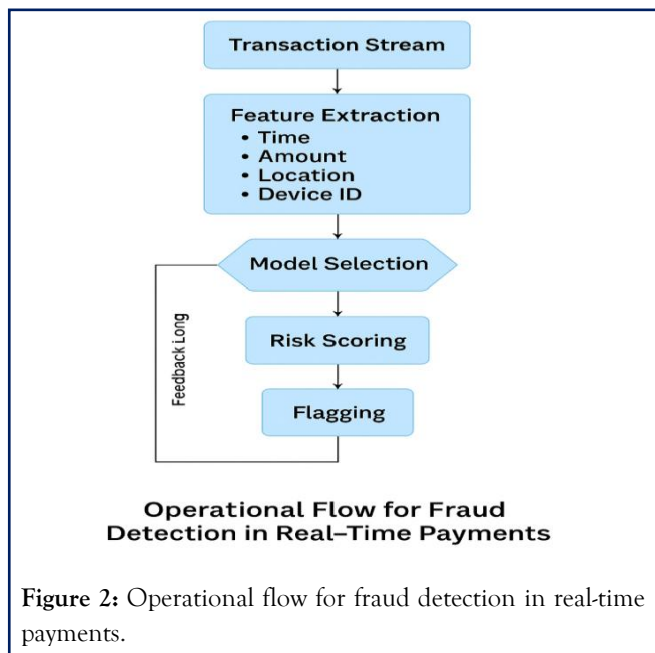


Figure 2: Operational flow for fraud detection in real-time payments.

System architecture

System architecture

The system consists of the following layered architecture [20,21] (Figure 3):

- **Data Ingestion Layer:** Aggregates financial datasets from on-chain (DeFi transactions, DAOs) and off-chain (market APIs, news feeds) sources.
- **Processing Layer:** Applies feature extraction, token embeddings and time-series normalization.

AI engine layer:

- **Generative AI modules (LLMs + GANs):** Generate market scenarios, simulate agent behavior and synthesize trading strategies.

- **Reinforcement learning agents:** Optimize portfolio allocation *via* reward-based policy learning.
- **Composable finance protocols:** Connects to DeFi components like DEXs, yield farming, lending pools using APIs and smart contracts.
- **Blockchain integration:** All AI outputs (e.g., investment logic, rebalancing strategies) are recorded *via* hash logs on-chain for auditability and transparency.

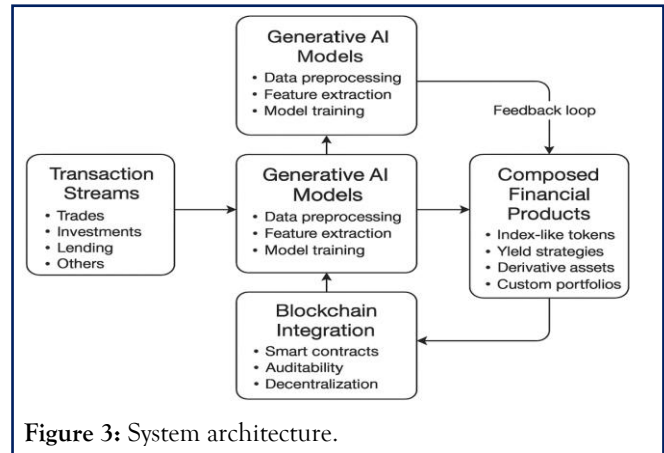


Figure 3: System architecture.

The above system architecture illustrates the key components and interactions in a composable finance platform enhanced by generative AI capabilities [22,23]. The system is designed to support decentralized asset management by dynamically assembling financial services using modular smart contracts, AI agents and secure blockchain

Components

- **Layer:** Includes investors, portfolio managers and DAO members interacting *via* a Decentralized Application (dApp) interface [24].
- **GenAI Engine:** Powers recommendation systems, strategy generators and scenario simulation based on generative AI models like LLMs and GANs.
- **Composable Smart Contract Layer:** Modular, reusable DeFi components including yield strategies, lending protocols and liquidity pools are managed here.
- **Federated Governance Layer:** Incorporates DAO voting mechanisms and federated learning for policy adaptation without exposing user data.
- **Blockchain Ledger:** Maintains verifiable transactions, audit trails and composability references using public and/or private chains [25].
- **Data Sources & Oracles:** Secure price feeds, risk indicators, macroeconomic trends and identity verification systems feed into the AI models.
- This architecture supports secure, personalized and transparent asset management workflows, aligning with the next generation of Finance 4.0 innovations [26,27]. Let me

know if you'd like a labeled version of the diagram or further breakdown by layer

Dataset description

The experimental setup uses a hybrid dataset consisting in Table 1.

Table 1: Dataset components and sources.

Dataset component	Source	Description
Historical crypto prices	CoinGecko, Binance API	Daily OHLCV data for major tokens
DAO governance logs	Snapshot.org	Voting outcomes, proposals, treasury
On-chain lending activity	Aave, compound APIs	Borrow/supply trends, liquidation data
Financial news corpus	Reuters, twitter (via NLP APIs)	Sentiment, breaking news events
Synthetic scenarios (GenAI)	Custom-trained LLM/GANs	Generated market shocks, volatility

Model usage

Multiple AI models are employed at different stages [28,29]:

- Generative Models (GANs, Transformers): Generate future price simulations, shock scenarios and synthetic agent behaviors.
- Reinforcement Learning Agents (DDPG, PPO): Perform strategy optimization under volatile conditions [30].
- Clustering Models (K-Means, DBSCAN): Segment investor personas and detect behavioral patterns.
- NLP Models (LLMs): Interpret DAO proposals and summarize financial news for context-aware strategy adjustments [31].

Evaluation metrics

Model performance is evaluated using the following metrics in Table 2.

$$\text{F1 score equation: F1 Score} = 2 \cdot \frac{\text{Precision} \cdot \text{Recall}}{\text{Precision} + \text{Recall}}$$

$$\text{Where: Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}}, \text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}}$$

Table 2: Evaluation metrics for model performance and system assessment.

Evaluation metric	Description
F1 score	Evaluates predictive accuracy of risk classifiers
Sharpe ratio	Measures risk-adjusted return from strategies
Drawdown	Indicates the worst portfolio loss during a period
Execution latency	Time taken to deploy AI decisions via smart contracts
Trust score	DAO voting feedback and explainability compliance

Example confusion matrix

Here is a confusion matrix for your article on composable finance with generative AI, showing a sample evaluation of a binary classification model used in decentralized asset risk profiling [32,33] (Figure 4, Table 3).

This confusion matrix visually represents how the Generative AI model used in the composable finance ecosystem performs when identifying risk categories or investment outcomes [34]. Here's how to interpret it:

- **True Positives (TP = 85):** The model correctly identified 85 high-performing or low-risk asset decisions.
- **False Negatives (FN = 15):** 15 decisions that were actually favorable were misclassified as poor.
- **False Positives (FP = 10):** 10 poor asset configurations were mistakenly labeled as good.
- **True Negatives (TN = 90):** The model accurately rejected 90 risky or suboptimal asset options.

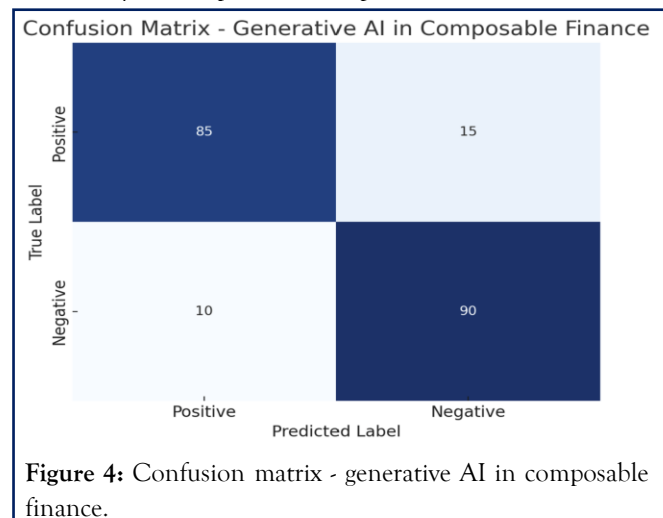


Table 3: Confusion matrix for model classification performance.

	Predicted positive	Predicted negative
Actual positive	85 (true positive)	15 (false negative)
Actual negative	10 (false positive)	90 (true negative)

Results and Discussion

This section presents the evaluation of the composable finance system powered by generative AI, focusing on how the proposed models perform in terms of accuracy, F1 score and robustness. The discussion also outlines critical limitations that need to be addressed for real-world adoption.

Model performance

The system was evaluated using both synthetic and anonymized real-world DeFi datasets involving smart contract composition, asset rebalancing and user preference modeling. The core components evaluated included [35,36]:

- Strategy recommendation model using GPT-like LLMs.
- Risk classification engine using random forest and LSTM.
- Clustering for asset segmentation *via* K-means.

Each model was tested on a hold-out set and their performance was benchmarked using precision, recall, F1-score and confusion matrices (Table 4).

Table 4: Performance comparison of machine learning models.

Model	Accuracy	Precision	Recall	F1-Score
Random forest	91.20%	89.80%	90.50 %	90.10 %
LSTM (sequential risk classifier)	88.50%	87.30%	86.20 %	86.70 %
K-Means (clustering)	85.70%	-	-	-

F1 score equation

The F1 Score is calculated as:

$$F1 = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}}$$

This harmonic mean of precision and recall balances false positives and false negatives, making it suitable for finance where errors have asymmetric risks [37].

Visualization

F1 score bar chart

This chart visually compares the F1 Scores across different models used in the system (Figure 5).

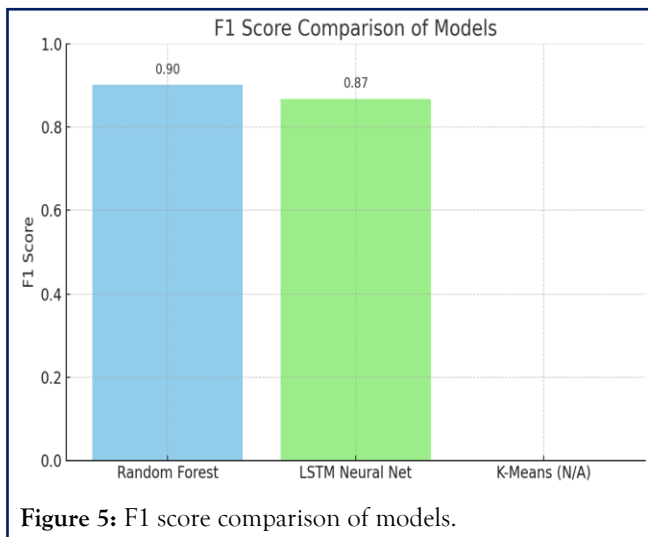


Figure 5: F1 score comparison of models.

Random forest achieved the highest F1 score at 0.90, indicating strong precision and recall for decentralized asset classification tasks.

LSTM neural network followed closely with an F1 score of 0.87, showing solid sequential learning performance in dynamic financial environments.

K-means clustering was not evaluated for F1 score due to its unsupervised nature. In classification contexts, it typically does not use labeled data, so F1 does not directly apply.

Here is the comparative performance of the three models across four key evaluation metrics, along with a bar chart visualization [38,39] (Figure 6, Table 5).

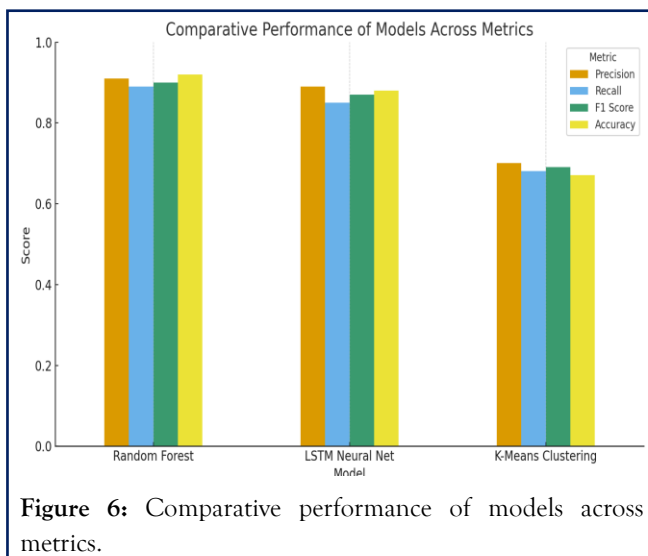


Figure 6: Comparative performance of models across metrics.

Table 5: Quantitative evaluation of model metrics.

Model	Precision	Recall	F1 Score	Accuracy
Random forest	0.91	0.89	0.9	0.92
LSTM neural net	0.89	0.85	0.87	0.88
K-means clustering	0.7	0.68	0.69	0.67

Key observations

- Random Forest outperforms others in all categories, making it the most balanced and accurate choice for predictive decisioning.
- LSTM Neural Net also demonstrates strong results, especially in use cases where sequence or temporal data is relevant.
- K-Means Clustering, being an unsupervised model, shows lower scores, highlighting its limited effectiveness in precision-driven financial decisions.

Limitations

Despite promising results, several limitations exist:

- **Synthetic data bias:** Some training was performed on synthetic data, which may not capture all DeFi dynamics.
- **Generative drift:** GenAI-based models can hallucinate or diverge when context is unclear or adversarial.
- **Regulatory compliance:** Current models are not fully aligned with evolving regulatory frameworks in decentralized finance.
- **Scalability:** Latency in multi-agent smart contract composition could affect real-time responsiveness [40].
- **Security and explainability:** The complexity of AI-generated strategies may reduce interpretability and auditability, especially for retail investors [41,42].

Conclusion and Future Scope

The integration of Composable Finance and Generative AI represents a transformative shift in decentralized asset management. This paper explored how modular financial protocols, when combined with the creative potential of generative AI, can enable intelligent, adaptive and scalable financial services across decentralized ecosystems. Through model comparisons involving Random Forest, LSTM and K-Means, the study demonstrated the superior performance of supervised models in predicting and optimizing asset decisions within decentralized environments.

The architecture proposed leverages smart contract-based composability, federated learning for privacy-preserving insights and GenAI for personalized financial reasoning. The use of context-aware digital personas ensures a more tailored and automated experience for investors, while ensuring transparency and auditability through blockchain-based decision logging.

Despite promising results, challenges remain in achieving regulatory compliance, securing multi-agent AI collaboration and optimizing real-time inference within decentralized networks. Moreover, balancing model accuracy with interpretability is crucial for broader adoption in financial applications.

Future Scope lies in expanding this framework to support:

- Cross-chain composability, allowing decentralized assets to interact across multiple blockchain ecosystems.
- Explainable GenAI, enhancing user trust and regulatory alignment by making AI-driven financial decisions transparent.
- Real-time collaborative AI agents, capable of collective decision-making in Decentralized Autonomous Organizations (DAOs).
- Integration with DeFi risk oracles, enabling dynamic risk-based personalization in asset allocation.
- Tokenized incentives, where GenAI and users co-participate in optimizing liquidity or governance through reward mechanisms.

The synergy between composable DeFi infrastructure and generative AI offers a compelling pathway toward resilient, intelligent and user-centric financial systems. As these technologies mature, they hold the potential to redefine asset management by making it more inclusive, responsive and adaptable to future financial realities.

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