Danu

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An Automated Market Maker (AMM) for Non-Fungible Tokens (NFTs)

Abstract

NFTs are predominantly illiquid assets; the non-fungible nature of NFTs complicates order matching, their high volatility complicates market making, and both aforementioned factors hinder fair and accurate appraisal of NFT value.

Danu is an automated market maker (AMM) for NFTs that strives to improve the liquidity provisioning of NFTs on the Ethereum blockchain by allowing both trading at fair-market and liquidation price. Furthermore, Danu aims to develop an NFT-trading ecosystem that (i) allows liquidity providers (LPs) diversified exposure to NFTs while earning fees (ii) offers its traders fair and real-time prices, irrespective of market conditions.

This light paper illustrates the main concepts and conducts of Danu. Please consult our white paper for the full technical details.

1 The illiquidity problem of NFT markets

The decentralized finance (DeFi) community has embraced NFTs as viable complements to conventional fungible cryptocurrencies—with OpenSea alone surpassing $ 25 billion in volume in 2021 (Gabriele 2021). Despite this, NFTs markets still considerably illiquid[1]. For example, most profile picture (PFP)-based collection NFTs are not sold more than once[2], as presented in fig. 1.

Perhaps the most straightforward way to create efficiency in NFT markets and increase its liquidity is to create an NFT exchange. Neither the exchanges, nor aggregators, however provide tools or services that directly benefit liquidity, instead depending on excess demand to make up for the non-fungible nature of NFTs. External market makers (MMs) are thus

[1]We consider the term ”liquidity” to be rather misleading, as it conventionally refers to the ability to readily convert an asset without affecting the market price to a large extent. We continue using the term throughout this light paper because of its established prevalence.

[2]The data used only considers NFT transactions directly made on OpenSea.

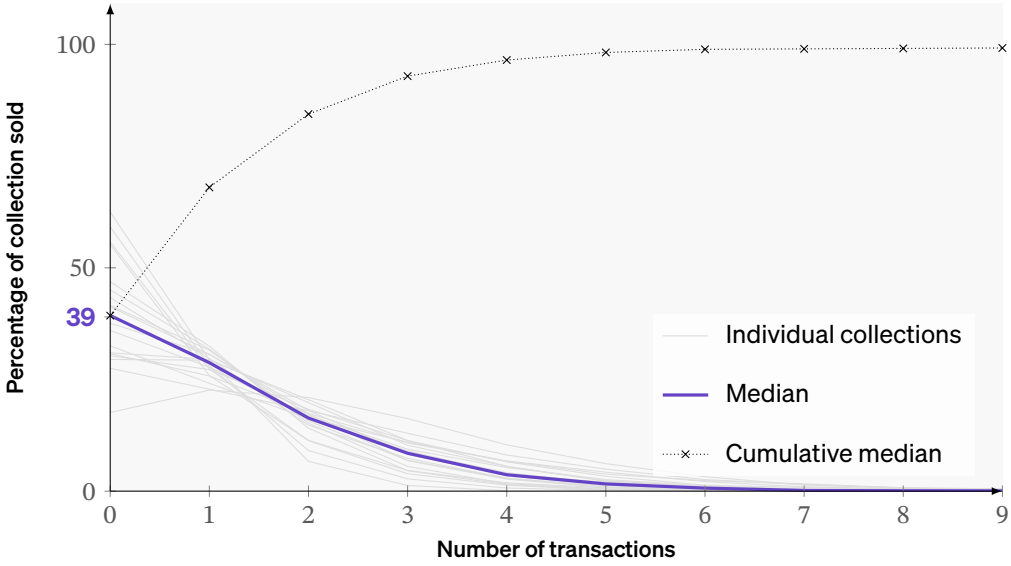

Figure 1: Pareto chart of the fractions sold of collections, and their median, against the number of transactions for the twenty most-traded profile picture (PFP)-based collections on OpenSea.

usually required by order book based exchanges to provide liquidity. A lack of such market makers could result in sub-optimal prices or even bring a complete halt to trading. Automated market makers (AMMs), alternatively, allow for automated trading via smart contracts. AMMs replace conventional MMs by utilizing a mathematical model to determine a price to swap assets at. Existing AMMs such as Uniswap[3], fail to realize the same efficacy as they do with non-fungible assets as with fungible assets because they fundamentally rely upon bonding curves for pricing. When such functions are applied to NFTs, they will effectively demote all assets to floor prices, essentially treating non-fungible assets as fungible.

We therefore believe that all of the above methodologies are insufficient to mitigate the illiquidity problems of NFT markets.

2 The proposed solution: The Danu NFT-AMM

Danu is an automated market maker (AMM) for NFTs on the Ethereum blockchain, with a marketplace on which individual NFTs in the pool can be swapped without having to interact directly with the smart contracts.

2.1 Why should I use Danu?

We discern three different kinds of notable use cases that we would like to elaborate upon:

[3]Automated market maker architectures like the one implemented by Uniswap are also referred to as constant function AMMs (CF-AMMs).

Liquidity providers LPs deposit their assets (i.e. $DANU, $ETH , or NFTs) into the respective liquidity pool. The LP retains ownership over the asset until the proposed transaction is confirmed and can withdraw his or her stake at any time. The LPs can list their assets at either the prices they specify, or the fair-market prices obtained from section 2.3.

→ LPs obtain diversified exposure to NFTs and are able to enjoy staking benefits such as passive yield from trading within the pool and governance rights, in addition to the commissions from transactions.

Sellers at liquidation price In contrast to LPs, sellers at liquidation prices pay a risk premium on top of the determined fair price and commissions to offset the inventory risk incurred by the liquidity pool—but obtain instant execution in exchange. The commissions are distributed between Danu and the LPs of the pool the NFT was locked in. When the NFT is subsequently sold, with the liquidity pool as the LP, the proceedings are restored in the pool.

→ Sellers are able to buy instantly at fair and transparent liquidation prices, effectively removing the need for a peer-to-peer counter-party.

Conventional buyers and sellers Traders wishing to swap NFTs have the possibility to do so on either the marketplace web-application. From there, traders are able to submit specialized buy, sell or cancellation orders to be executed and add filters to query for specific desirable feature sets.

→ Buyers and sellers are guaranteed up-to-date fair price at all times, eliminating the need for manual intervention when market conditions change and enabling traders to finely adjust their risk-return preference.

Both LPs and traders are guaranteed up-to-date fairly priced assets. Furthermore, as changes in the price point of an NFT are accounted for upon every interaction with the Danu NFT-AMM smart contract, the frequency of arbitrage opportunities and unexpected slippage is largely reduced.

2.2 Architecture and mechanism design

The core components of Danu are its two liquidity pools; one for the pair between arbitrary NFTs ↔ $DANU, where $DANU is our proprietary ERC-20 incentivization token, and one for arbitrary NFTs ↔ $ETH. The liquidity pools do not take the supply balance into consideration for the pricing of assets, such as conventional bonding curve AMMs do, but instead use a pricing model, as will be described in section 2.3. The architecture of the Danu NFT-AMM is illustrated with one such pool for simplicity in fig. 2.

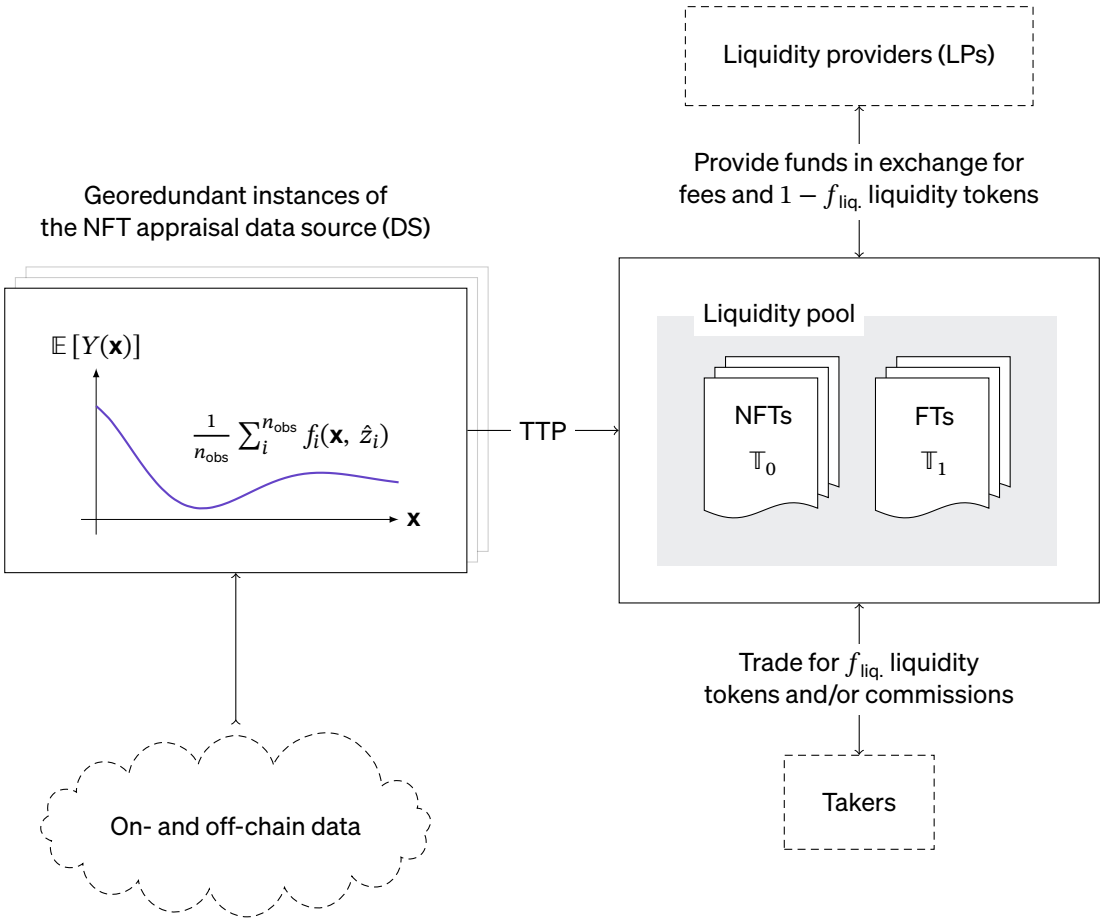

Figure 2: Illustration of the architecture of the Danu NFT-AMM; the NFT appraisal model data source (DS) provides the quoting price of an individual NFT to the smart contract (SC) that mediates between liquidity providers (LPs) and traders.

The $DANU token is used to incentivize desired behavior and provide instant liquidity to both pools; more $DANU will be minted by the NFT-AMM if and only existing liquidity provision is insufficient to sustain trading. As more $DANU are minted to prevent trading from coming to a standstill, their supply increases. However, since this only occurs in cases of severe oversupplies of inadequately priced NFTs, the $DANU LPs will be compensated for their stake and will further incentivize $DANU LPs to prevent additional minting. While both pools are implemented in the same manner, the $ETH pool cannot realize instant liquidity without using $DANU and thus remains susceptible to $ETH deficiencies.

Danu does not incur inventory on its own; all staked assets remain the property of their respective LPs when deposited in the pool, i.e. (i) NFT LPs deposit their assets into the pool for them to be traded at fair prices (ii) $DANU and $ETH LPs deposit their stake into the respective liquidity pools to be used for swapping against NFTs at a fair price plus, if the transaction is to occur instantly, a risk premium to offset the risk incurred by the pool. Because NFTs

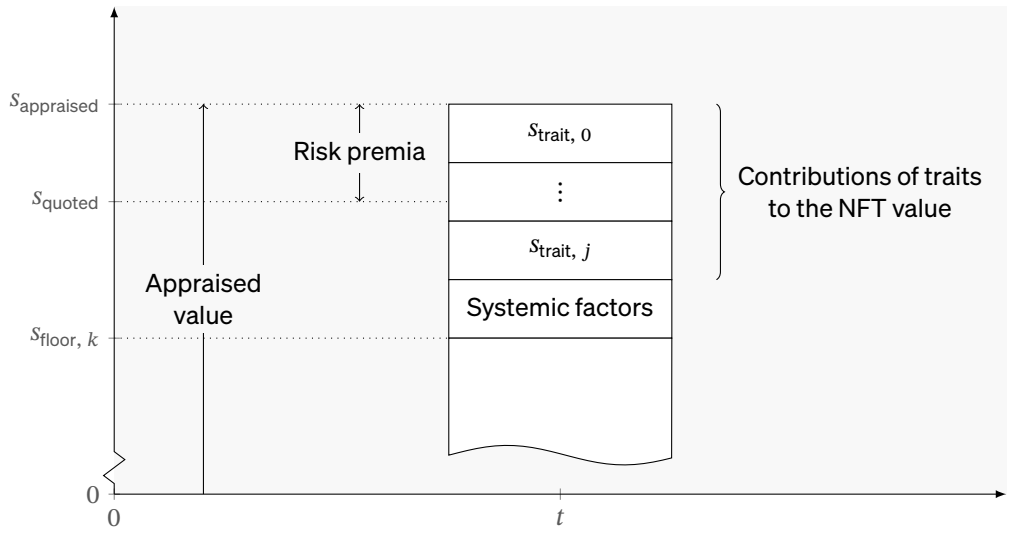

Figure 3: Illustration of the structure of our pricing model for an NFT with j number of traits in a collection k at an arbitrary point in time t. The individual NFT is appraised at $s_{\text{appraised}}$, after which risk premia (RP) are applied. This results in the price point s_{quoted}, at which the NFT is quoted at by the AMM.

are traded against the pools, the entire pool will receive LP commissions. We believe this architecture and mechanism design create a healthy and sustainable ecosystem where no party is treated unfairly.

2.3 Pricing model

Our NFT appraisal model is a direct extension of the work of Wang and Blei 2018 on causal inference. Their seminal paper introduces the deconfounder, a statistical algorithm that uses assignment models to explain outcomes by accounting for confounding variables[4]. We believe that the assumptions the deconfounder makes—and the relative ease with which the issues they impose can be tackled in our use case—make the deconfounder the best mathematical tool for the job currently available.

The pricing model used within the framework of the deconfounder considers systemic and idiosyncratic factors for the appraisal of the value of NFTs, as shown in fig. 3. The expected fair-market prices of the individual NFTs are computed by taking into account information at the market, collection, and trait level. In this hierarchical structure, market movements are allowed to affect the floor prices of the NFT collections and the collection movements can influence the individual NFTs.

Because of the high volatility of NFT markets, however, liquidity providers (LPs) are subject

[4]Confounding variables are indirectly relevant variables that cause spurious associations by affecting both the dependent and independent variable. An intuitive example would be alleging that the consumption of ice cream causes people to drown, when in reality a heat wave (i.e. the hidden confounder) may have caused both. Existing methods are inadequate to handle such cases.

Table 1: Preliminary roadmap for 2022.

2022	
March	Danu was founded
	Start of preliminary pricing mechanism research
April	Architectural and mechanism design ready
May	Start of in-depth pricing R&D
	Published our light paper, i.e. this document
	Published our white paper
June	Seed round
August	Launch of first version of the Danu NFT-AMM

to both systemic and idiosyncratic risk that should be accounted for in the formation of a quote price; while the AMM is able to liquidate traders' NFTs instantly, eliminating search cost, the NFTs inside a liquidity pool cannot be instantly liquidated. The Danu NFT-AMM therefore introduces a risk premium (RP), as shown in fig. 3, which consists primarily of a liquidity risk premium (LRP) and a volatility risk premium (VRP). An LRP is deducted from the fair price to mitigate some of the risk incurred by the liquidity pool. Analogously, a VRP is deducted from the fair price as NFTs in the pool are susceptible to volatile price changes while still in the liquidity pool.

For a comprehensive discussion on the aforementioned, please refer to our white paper.

3 Roadmap

The preliminary roadmap for the development of Danu as a company is given in table 1 for 2022. We have faith in that Danu will, using the architecture and mechanism design described in this light paper, evolve to be a cornerstone in the ecosystem of NFT-based decentralized applications (dApps) and services.

References

Gabriele, M. (Oct. 2021). "OpenSea: The reasonable revolutionary". In: *The Generalist*.

Wang, Y. and D. M. Blei (May 2018). *The blessings of multiple causes*. arXiv: 1805.06826.

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