Sanka DeFi – Working Paper

Saki

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1 Primer

This document spells out a high level with some technical detail on our proposal for Sanka DeFi. This paper is not intended to be an ultra-specific technical document that dives into every technical or architectural reality of building Sanka, but rather provides at a high level how Sanka DeFi along with the Sanka Score works. Additionally, some additional details on long term plans for Sanka's implementation are provided. This paper is a work in progress, and as such may contain various inconsistencies, typos, or idea's that are not yet fully fleshed out. As of writing (January 2023) the initial product offering of Sanka DeFi is intended to be the "Sanka Score" and as such, this paper includes less detail on future components, such as the Sanka Trust & Reputation Escrow Systems. Given this is still a work in progress we ask the reader to note this paper is subject to change prior to launch, and further ask the reader for patience as we work towards building our vision of free public infrastructure for credit, trust, and reputation scoring.

2 The Problem – DeFi's Fledgling Credibility

In 2022, credibility of the DeFi ecosystem was practically lost. Do Kwon's Terra imploded, leading to wreckage at Three Arrows Capital, Celsius, Voyager, Genesis, and FTX. Millions of new Crypto users got burned, some having lost a substantial portion of their life savings. Many on the sidelines have written off Crypto as a scam, and legislators globally have been given the ammunition to regulate Crypto & DeFi as to make it untenable for daily usage. While these individual's and entities made grandiose claims, measures of the trustworthiness of such claims were scarce, and ultimately rang hollow. While most true DeFi protocol's have made it out of the wreckage unscathed, the sin's of CeFi lenders have harmed the trustworthiness of the entire ecosystem. People it would seem have less trust in those behind the code, which is a major adoption hurdle for Crypto & DeFi.

Currently there are limited systems in DeFi to measure the trust, and reputation of actors in the space. Over the last 2 years numerous Web3 Credit Bureau's have emerged thanks to cheap VC money. They are offering user's

free credit scores and marketing their systems as being able to measure trust and reputation. These systems are generally opaque, most Web3 Credit Bureau's only offering high level overviews of how their score works due to concerns over being able to monetize intellectual property, and hosting such systems on complex and fragile web2 architecture. As of writing these credit scores have generally failed to be adopted by any of the major DeFi lending protocols, nor have they been adopted by users en mass for solving the trust and reputation problem. As the trust and reputation aspects of these scores only work when there is mass adoption of these scores at scale, at the current moment in time there is limited ability in the ecosystem to measure trust, reputation, and credit worthiness of pseudonymous identity's.

The consequence of there being limited ability to assess trust, reputation, and creditworthiness in the ecosystem is substantial reductions in capital efficiency. On major DeFi protocols, such as AAVE for example, for borrowers to keep their loans open, they need to maintain LTV's lower than 60%-80%. These LTV's are kept in place as these protocols are well aware that if the LTV exceeded 100%, these borrowers would happily put their undervalued collateral back to the protocol, walking away with the funds, effectively converting the lenders to that protocol into put sellers. Borrowers know they can do this do to lack of real world recourse, and that there is nothing truly substantial at stake as far as their trust and reputation are concerned. It is for this reason in the current environment under-collateralized lending has not been successful.

The lack of capital efficiency comes at great harm to borrowers, who are likely overpaying for credit due to the need to protect and hedge lender downside. As a result of this loss of capital efficiency, CeFi solutions have come into place in order to offer lending and deposit products at better terms, but as we know from the last 2 years, that has gone very poorly. As a result, one could take a pessimistic view of the current space: DeFi may be doomed to be far less capital efficient than CeFi or even TradFi. In order to solve this problem, DeFi needs a open & transparent solution for assessing trust, reputation, and credit-worthiness of actors in the ecosystem without needing to rely on web2 architecture, or be at the mercy of private interests. This is what Sanka DeFi looks to solve.

Sanka DeFi is Free Public Infrastructure for building trust, establishing reputability, and demonstrating creditworthiness. Built on the Optimistic Credit model, powered by the Canto Ecosystem, Sanka delivers on the promise of a free and open financial system.

3 What is Sanka DeFi?

Sanka DeFi is open finance sans centralized entities. That means a pure web3 experience, not tied down or reliant on any web2 or other old world dependencies. Sanka DeFi delivers on the promises of a free and open financial system via the Sanka Score. The Sanka Score is at the core of 3 key problems in DeFi:

1. Trust – Modern financial systems work because trust is easily scalable.

At the same time trust is fragile, and these systems can fail miserably in spectacular ways for this reason. For DeFi to operate in an efficient way, trust has to be easy to validate in an open and transparent way. Sanka Score enables decentralized trust via the Sanka Trust Escrow system.

2. Reputation – A proxy for gauging the trustworthiness of statements made by any individual, corporate, or other public entity is the reputation of that entity. It is common that many individual's and smaller entities can establish their trustworthiness by becoming member to a larger and more reputable organization. This larger organization maintains it trustworthiness by carefully selecting for it's members, thus awarding those members access to trust to make claims, commitments, and obligations on behalf of the larger organization. A great example of this in real life large corporate entities or well established DAOs. Sanka DeFi enables scalable sharing of reputation via the Sanka Reputation Escrow System, enabling members to benefit from established reputation of larger organizations they are member to.

3. Creditworthiness – For a financial system to efficiently transmit dormant capital from savers to borrowers with an ability to invest that capital, that systems needs a way to gauge whether or not those borrowers will be able to make good on those loan obligations. In DeFi, for the most part, all credit is over-collateralized, which is highly inefficient, and not scalable. Sanka Score, gauges trust & reputation based on an entity's ability to continually make good an commitment on obligations by tying financial stake to those promises. A very natural type of obligation and commitment that can be measured in this way is a loan, and as a result, the Sanka Score is a reasonable proxy for credit risk.

4 Sanka Credit Score

4.1 Overview

The Sanka Credit Score is at the core of the Sanka DeFi ecosystem, and Sanka DeFi's proposed initial product offering. Trust & Reputability are fundamental to Credit, and the Sanka Score measures credit-worthiness by tracking the performance a given entity to make good on it's loan obligations. All scorable entities in the Sanka Ecosystem are assigned a starter score. Once assigned a starter score, as the entity originates new obligations, makes repayments on new obligations, and experiences liquidations on said obligations, their score will increase or decrease. The score can then be interpreted by an Effected Entity as to what terms the opposing entity can enter into new obligations into with it; such as loans, promises, or other such trust based obligations. As the Sanka Score is a direct proxy for broad spectrum credit risk, it roughly measures the probability that

an obligor will make good on it's obligations. This allows the Sanka Score to be a basis not only for Credit, but Trust and Reputation.

4.2 Computation

The Sanka Score is based on the the principal of Bayesian Inference. It starts out by making an initial assumption, represented by a set of set parameters, about an entity when they come into existence, then allowing the behavior of that entity to migrate the score over a period of time. This migration is driven by an increment function that takes an input about an event regarding the borrower, and outputs an increment to a set of state parameters that describe that borrower. These state parameters can then be used to parameterize a probability distribution, that can be used to ask questions about how likely the borrower is to do something; e.g. default on a loan.

4.3 Getting a Probability – The SPM

The Sanka Probability Model, referred herein as the SPM, refers to the linkage between the underlying Beta Distribution, and Increment Function that makes it possible for Sanka to produce a probability estimate regarding default risk for an entity.

4.3.1 Beta Distribution

A beta distribution models the likelihood of a Bernoulli Event. A Bernoulli Event is any event that takes a 0, or 1 outcome, such as a coinflip. A beta distribution allows us to ask such questions such as "what is the probability that the probability of observing event 'x' is less than p?" In the context of lending this makes a lot of sense. A loan, once issued, can ultimately take an outcome of one of the 2 following types of events "Defaulted" and "Non-Defaulted". While there are a variety of ways a loan can be kept healthy in the "Non-Defaulted" case, we are primarily focus on the "Defaulted" state. For most DeFi lending protocols, the "Defaulted" state, is when the loan is fed to the liquidators (example AAVE). Let us represent the "Defaulted" state as a 1, and the "Non-Defaulted" state as a 0. We can now ask the question "what is the probability that the probability of observing event '1' is less than p". Now we can phrase the Default Risk "p" in terms of a beta distribution.

A Beta Distribution is rather simple in formation; see: Beta Distribution . Fundamentally it takes 2 parameters: α, β. Here "α" can represent positive or "good" credit risk, and "β" can represent bad credit risk. This gives us some useful properties

(a) We can represent the expected default risk of a borrower as $p = 1 - \frac{\alpha}{\alpha+\beta}$

(b) We can represent the variance around that estimate as $v = \frac{\alpha\beta}{(\alpha+\beta)^2(\alpha+\beta+1)}$

(c) Following a Bernoulli distribution, we can get a confidence interval around that estimate as $[p - z*\sqrt{v}, p + z*\sqrt{v}]$, where the upper bound gives a conservative estimate of risk, and the lower bound gives an aggressive estimate of risk for some reasonable choice of "z" say "2".

The principal of the SPM is to dynamically calibrate a choice of α & β so that the outputted probability estimate "p" is consistent with the typical default rate averaged across a group of similar entities looking forward from the calibration time; the SPM is creating a forward looking estimate of risk, not reporting historical risk. In layman's terms, if we say the chance of rain is 10%, it better rain only 10% of the time after we say it is. If it is, we say our probability forecast is "well calibrated".

4.3.2 Increment Function

The increment function takes an input of events about an entity and outputs a vector of floating point changes to make to the parameters of the beta distribution. This is how new information gets incorporated into the Sanka Score.

There are a wide variety of possibilities for how this increment function could work, and we are not going to attempt to list all possible combinations, nor recommend a particular choice of increment function as superior to another particular choice or combination. Instead in this document we propose a particular choice for our initial release which we believe is reasonably flexible, and could be voted on and changed by the community. Our proposed increment function for initial release works based on 3 primary loan events "origination", "repayment", and "default/liquidation".

Increment on Origination On origination, principally, the risk of an entity ought to become elevated. As an entity takes on more debt, their capacity to continue to service new debt falls. This is due to capital, generally speaking, being a finite resource.

In an ideal world, this increment would function based on some prior knowledge of previous debt that borrower was able to successfully service, indexed to some stable price index, such as the US Dollar. We may attempt this for future releases, but at this point in time this is not feasible without building dependencies on third party price oracles which may be centralized.

To make the score as universal as possible, and agnostic to both the borrower wealth and the borrowed asset, we focus on a penalty based on

length of serviced history. Borrowers with a longer history will receive less of a penalty on new origination, while borrowers with a fresher history will receive less of a punishment. Length of history can be pinned down based on the sum of α and β.

We can do this as follows:

$$\beta \coloneqq (\beta + c_0 * ln(1 + \frac{\zeta_0}{\alpha + \beta}))f(\alpha + \beta) \tag{1}$$

Here the choice of ζ_0 determines the inflection point where new origination starts having a decreasing penalty on score. This effect can then be amplified by tuning c_0. For reasonable choices of c_0, ζ_0 the increment will be bounded between 0,2 for most increments. The function $f : x- > [0, 1]$ takes the sum and maps it between 0 and 1. This creates the effect of having some history be naturally forgotten overtime. This can be thought of as the credit stickiness function. We elaborate on that more in a following section.

When the borrower is new this increment will be much larger, harming their score. This makes sense as a new borrower with a lack of history should naturally be treated with a greater degree of skepticism than a borrower with more established history when taking on more debt.

Increment on Repayment Repayment will have the effect of improving the borrowers score. In an ideal world we would be able to track the value of the outstanding debt, and compute an increment relative to the portion of debt that was paid off. However, in the spirit of producing a pure score, here we look to compute an increment that is agnostic to borrower wealth. We envision that this could look like something similar to the following:

$$\alpha \coloneqq (\alpha + c_1 * ln(1 + \frac{\zeta_1}{\alpha + \beta}))f(\alpha + \beta) \tag{2}$$

Similar to the origination case, as the sum crosses the inflection point determined by ζ_1 the increment slows down. The term $c_1$can be used to amplify or dampen the effect. The credit stickiness function here is the same and is defined further below.

Increment on Default / Liquidation Naturally default or liquidation should harm a borrowers score. In an ideal world, this could be done by looking at the amount that was defaulted / liquidated relative to the typical amounts of money borrowed by the entity. However here we look to build an increment that is agnostic to borrower wealth. Roughly we envision this as follows:

$$\beta \coloneqq (\beta + c_2 * ln(1 + \frac{\alpha + \beta}{\zeta_2}))f(\alpha + \beta) \tag{3}$$

This function is slightly different in that as the sum grows the increment logarithmically grows, accelerating beyond the inflection point ζ_2, using c_2 to amplify the effect. The reason for this change is to reflect that in absolute terms default / liquidation is much more costly than repayment. As a result, the punishment should be sufficiently harsh. We believe by fine tuning these parameters, we can create a sufficient punishment for bad behavior without going as far as doxxing identity or user addresses. None the less, this information is publicly available on chain, so in theory being able to view someones score that has gone down should be a sufficiently strict punishment.

Credit Stickiness Function We believe that people have a right to have their past behavior forgotten and forgiven over a long period of time. We also believe that prior good behavior from long ago is not necessarily reflective of an entity's morals, ethics, or propensity to repay at the current point in time. Thus, a good credit score should naturally care more about an entity's current behavior, rather than something they did long ago. To do this, we are proposing the increment function should be guided by a credit stickiness function. This could work like something similar to the following below:

$$f(x) = max(1, c_3 * ln(1 + \frac{\zeta_3}{x})) \tag{4}$$

Where $\zeta_3, x > 0$

This has the effect of shrinking the absolute value of the new values for α, β over time as $\alpha + \beta$ grows relative to ζ_3 and creating a cap to where the rate of credit migration normalizes. The rate of credit migration could then be sped up or slowed down by the community choosing different values for c_3, ζ_3

4.4 Risks

The primary risk from a credit perspective in the proposed methodology is that it is agnostic to the the quantity of money borrowed, and as a result the sizing of loans, particularly relative to what a borrower is normally extending, are not reflected in any of the increments.

Some other risks are as follows

(a) Particular parameter choices may lead too improvements that are to fast / slow given preferences of a particular community that wishes

to rely on the score. This could lead to divergent interpretations of risk across the ecoystem.

(b) The choice of how sticky credit should be is arbitrary and may lead to bias in the estimate of the SPM.

(c) Low gas costs can lead to rapid increments via micro lending where bots could quickly game for a better score. How to identify this type of manipulative behavior, and protect against it, is a challenging problem.

4.5 Converting SPM output to Sanka Score

We believe every protocol should be free to decide what scoring scale make the most sense to them, and as a result offer people the direct ability to make read only calls directly to the SPM. This will enable DeFi protocols to tweak the SPM to fit their needs by potentially re-scoring borrowers based on additional factors, models (be it on or off chain), or context that is specific to a particular protocol.

Regardless, Sanka does provide a reasonable base score that follows naturally from a direct interpretation of the SPM.

4.5.1 Methodology

Recall that a beta distribution can be used to compute the expected value of probability associated with a Bernoulli trial.

We propose a simple score that would range from 0-100 based on interpreting the probability of an entity not defaulting on a given loan based on the values of α, β from the SPM:

$$S_{\text{score}} = I(100\frac{\alpha}{\alpha+\beta}) + 1\{I(2\frac{\alpha}{\alpha+\beta}) > 0\} \tag{5}$$

Where $1\{\dots\}$ is the indicator function taking a value of 1 when the inequality is true otherwise 0 when the inequality is not true, and $I(\dots)$ is the integer part of a real number. Effectively, we are multiplying the output probability into 100 to make it into a percentage, then rounding to the nearest whole number.

Using this method, the score would very directly translate into an easy to interpret probability of an entity being a good borrower. A score of 99, would mean that Sanka expects a 99% chance that the entity associated that score repays or maintains their debt obligations in line with the loan terms extended. Likewise, a score of 1 would mean a 1% chance of doing this. This allows the Sanka score to be used as a baseline estimator in any DeFi Lenders underwriter, and provides a good starting point for what the creditworthiness of an entity before considering a wider set of features and other mitigating factors.

4.6 Open Questions

Some open questions we at Sanka DeFi are still exploring on our Scoring methodology:

(a) How can we protect the ecosystem from bots looking to game for high credit scores?

(b) What parameterization should be used at launch?

(c) Should the Credit Stickiness function be universally applied at each lending event in the way it is proposed?

In a future iteration of this document, we hope to have answers to these questions along with fleshed out solutions.

5 Sanka Trust Escrow

At it's core trust implies that if an individual or entity makes a claim or enters into a commitment, or obligation that can become falsifiable, that this individual or entity will make such claims in a truthful honest manner and/or make good on such claims and commitments. Generally trust is earned between two or more parties over a long period of time by continually making true claims, and making good on obligations or commitments. In DeFi, the pseudonymous and trust-less nature of the environment does not naturally lend itself to building trust with individuals or other such on-chain entities. We can audit the code if it's open source, but we don't necessarily know if those individuals behind the code & addresses themselves are trustworthy. In order to establish this, Sanka offers a Trust Escrow system based on the notion of a 0 interest collateral obligation. The Claimant Entity (the entity making the claim or wishing to take on an obligation) puts an amount of collateral to the Effected Entity. The collateral is held in escrow by Effected Entity until a the claim is validated or the obligation or promise is satisfied as verified by Sanka DAO. If the claim is found to be false, or the obligation or promise is not met, then the collateral is liquidated and delivered to the Effected Entity as Liquidated Damages for the violation of trust, along with a severe devaluation in their Sanka Score. If found to be true, the collateral is made available for withdraw, or re-collateralization to back further trust based obligations.

6 Sanka Reputation Escrow System

Building trust from 0 is hard for many individuals and smaller entities. Often it is easier to build trust when a more trustworthy or reputable

entity is willing to stake their reputation against your trustworthiness. A common example of this in real life is the reputation bestowed to you based upon say a company you work for. As an individual you may be rather inexperienced, but if that larger company or organization is willing to stake it's reputation on your actions, then it is easier for you to make progress in the relevant field to that organization. The Reputation Escrow System works by enabling smaller members of an organization to borrow collateral from the larger organization to enter into collateralized trust obligations. Effectively the member entity to the organization enters the trust obligation on the organizations behalf, staking the organizations Sanka Score to those trust obligations. The organization may be willing to do this as members may know each other in real life, or other sorts of associations. In order to prevent endless abuse by smaller members, membership to the Reputation Escrow is established by the smaller entity entering into a trust obligation with the organization, promising to make good on all claims, obligations, and promises it agrees to enter behalf of the organization. As long as the member makes good on all such obligations, it's stake to the organization is maintained, and it can continue to make more serious commitments for which the member doesn't have sufficient individual trust. In turn the Sanka Score of the Organization and member improves, allowing them to convince market participants to trust them with lower collateral to back increasingly severe obligations.

7 Implementing Sanka DeFi

At the core of Sanka DeFi is the Optimistic Credit Scoring Model.

7.1 Overview

Every good protocol needs a strong design that allows for usage that is cheap, secure, auditable, and upgradable. Sanka Protocol is not unique in that respect. However, Sanka Protocol seeks to solve on chain credit scoring, a problem that has yet to have any viable native Web3 implementation. Existing web3 credit protocols are GCP / AWS solutions that link to credit oracles (Web 2). These protocols suffer multiple points of failure: GCP can go down, indexing services (such as the graph protocol) can go down, and any protocol which externally depends on these "Web 3 credit bureau"'s has to build their own RPC to link up to a web 2 scoring API. On top of all these problems, all of the existing Web3 credit bureaus do not expose their scoring algorithms, leading to a lack of transparency and trust into how the score was computed and how the reported credit risk should be interpreted. Sanka seeks to move scoring algorithms on chain in order to eliminate web2 dependencies and provide completely transparent

measures of both credit / trustworthiness. Our vision for how this can be done can be best phrased by "Optimistic Credit Scoring".

7.2 Proposed Solution - Optimistic Credit Scoring

Simply put, a user's credit trustworthiness at time $\boldsymbol{t}$ is the summation of all their positive, negative, and neutral credit events. To build an accurate scoring system, a protocol must ensure the validity of:

(a) a credit event's effect on a score

(b) the inclusiveness of every relevant credit event.

An unscrupulous borrower has a natural incentive to omit negative credit events, thus boosting their score and increasing lending power, however, the problem stands that EVM blockchains do not have the ability, or the compute power, to perform the necessary introspection to compute against an arbitrary amount of historical events.

Previous credit scores have encountered a "credit trilema" of decentralization, gas-costs, and on-chain usability. To solve the on-chain creditworthiness problem, you must either "route" all lending transactions through a scoring contract at runtime (implausible from a product-integration perspective, and highly inefficient for users) or you analyze historical events off-chain with your own model, storing the users scores on a contract (centralization risk, opaque scoring rules).

Sanka attempts to solve these issues using an Optimistic *Sentinel* <> *Attester* model

The proposed architecture - based on optimistic bridging systems like Nomad and Connext - will allow for:

(a) a decentralized, open-source, and community-upgraded scoring algorithm

(b) an on-chain, fraud-resistant, gas-efficient, and opt-in credit score for users across DeFi

A user (***attester***) will attest to their own score by calling "generateScore" on the Sanka smart contract. This "generateScore" function will:

(a) accept a "honesty escrow" in ETH.

(b) store the generated score on-chain

(c) emit an "ScoreAttestation" event containing a ***score*** and a ***processed*** transaction ***checksum***.

Sentinels will watch for "Attestation" events and verify both the ***score*** and the ***checksum***. If the score is emitted on-chain for longer than a ***curetime*** (e.g: 2 hours), then their score is considered valid.

However, if a ***sentinel*** discovers that an attestation is fraudulent, it can ***counterAttest*** stating both a correct ***score*** and a correct ***checksum*** if their counter attestation is unchallenged, then they receive the honesty escrow as a reward.

8 Sanka DAO

8.1 Role of Sanka Dao

Sanka DAO will sit at the core of governance for Sanka DeFi. The DAO serves a few key purposes in the ecosystem

(a) Governance

(b) Maintain code

(c) Propose changes & new features

Initially at launch, Sanka DeFi will be directly administered by the Sanka Foundation. After a period of time, once the ecosystem has matured and a strong solution for implementing Sanka DAO is in place, the Sanka Foundation will step away at that time.

8.2 Thoughts on Governance

Governance of Sanka DAO will likely prove tricky, given the perverse incentives there are to pass changes to scoring algorithms that will benefit large players. While in an ideal world, the wisdom of the crowds would converge on a solution for the increment function that makes the score as agnostic to any particular protocol, accurate, and minimally biased, the reality is that the incentive to drive changes to enable inappropriate borrowing from large players may be strong. The goal is to have a governance scheme that is makes it harder for large players to pass perverse improvement proposals or other changes to the code base. We believe that a scheme based on Quadratic Voting may provide the best solution here, however more research will be necessary prior to launch.

8.3 Does Sanka DAO need a Token?

As well put by Vitalik, governance tokens suck and it would be nice to see some solution that doesn't use Governance tokens. Right now, this is an open area of research for Sanka DeFi, and we will elaborate further in

future iterations of this paper. One possibility includes Soul Bound 1155 tokens following a quadratic voting scheme, however further research is needed.

Some other ideas include:

(a) Non-transferrable governance tokens via a Moloch DAO

(b) Snapshot voting via SafeSnap and Gnosis Safe

(c) Voting power 1:1 with Sanka score

9 Final Thoughs & Next Steps

As you can likely tell by reading through our working paper, Sanka DeFi is very much still in it's infancy and there is much research to be done. At launch, our initial product offering will be the Sanka Score, which will track borrow, repay, and liquidate events on major DeFi lending protocols. Our goal is that Sanka Score will serve as a benchmark mark for credit risk in the DeFi ecosystem. From here, we can branch out additional solutions.

Some additional work that needs to be done prior to launch

(a) Construction, testing, and optimization of Optimistic Credit Scoring model

(b) Simulation and selection of initial parameterization of increment function for Sanka Score

(c) Architecting of Sanka DAO

Ultimately while we believe Sanka Score will prove to be a robust base Estimator of broad credit risk in the ecosystem, it will likely be a weaker estimate credit risk than what could be provided by a machine learning estimate, or some other fine tuned application specific solution. We see Sanka Score being used a base estimate of risk, that could further feed into more specific or complex estimates of risk for specific applications. While Sanka Score can't truly see all, we believe that DeFi deserves a respectable piece of free public infrastructure to bring credit, reputation, and trust to a DeFi ecosystem that desperately needs it.